UNIVERSITY OF VERMONT

AND STATE AGRICULTURAL COLLEGE

SIXTEENTH

ANNUAL REPORT

OF THE

VERMONT AGRICULTURAL

EXPERIMENT STATION

BURLINGTON, VT.

1902–1903

BURLINGTON:

FREE PRESS ASSOCIATION
PRINTERS, BINDERS, STATIONERS
1903

THE VERMONT Agricultural Experiment Station,

BURLINGTON, VT.

BOARD OF CONTROL

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W. J. MORSE, Assistant Botanist.
E. H. GREGG, Dairyman.
MARY A. BENSON, Stenographer.
E. H. POWELL, Treasurer.

†Resigned October 1.

ANNOUNCEMENT

The Vermont State Agricultural Experiment Station was established in accordance with an act of the General Assembly, approved November 24, 1886, for the purpose of promoting agriculture by scientific investigation and experiment. The Station was established in connection with the University of Vermont and State Agricultural College, and for the past sixteen years has received the funds appropriated by Congress under the provisions of the act commonly known as the "Hatch Act," approved March 2, 1887. The state appropriation expired in 1890. An appropriation "not to exceed $1000 annually" was made by the legislature of 1898 for the purpose of printing the annual report, and one of $500 by the legislature of 1902 to defray the expenses of the inspection of feeding stuffs

The Station is prepared to analyze and test fertilizers, cattle foods, seeds, milk and other agricultural materials and products—exclusive of water and human foods which should be sent to the State board of health laboratory, Burlington—to identify fruits, grasses, weeds, blights, insects, etc., and to give information on various subjects connected with agriculture for the use and benefit of the citizens of Vermont. The identification or analysis of minerals does not lie within the province of station activities. Such samples and inquiries should be sent to the State geologist, Burlington.

All chemical analyses, etc., proper to an Experiment station, that can be used for the public benefit, are made without charge, so far as time and means permit. The Station will undertake no work the results of which are not at its disposal to use or publish, if deemed advisible for the public good. The results of such analyses will be promptly communicated to the party sending the sample. Those that are of general interest are published in the annual report or in the bulletins.

It is the wish of the Board of Control to make the Station as widely useful as its resources will permit. Every Vermont citizen who is concerned in agriculture, whether farmer, manufacturer or dealer, has a right to apply to the Station for any assistance that comes within its province to render, and it will respond so far as lies in its power. All communications relating to agriculture, horticulture, plant or animal diseases, insects, etc., will be fairly considered, and, so far as possible, promptly answered.

The main Station building is located on Main street at the south end of the College park. . The farm and its buildings are on the Williston road, adjoining the University grounds on the east. Electric cars pass at Colchester Avenue and University Place, within a third of a mile of the Station building. Both the Station and the farm have telephone connections.

Instructions for taking samples of fertilizers, fodders, milk, seeds, etc., will be sent on application. Parties desiring to send samples should first write for these directions. Many samples received are useless, being incorrectly drawn. Parcels by express, to receive attention, should be prepaid and should bear the address of the shipper for purposes of identification.

Copies of the reports and bulletins of the Station are sent free of charge to any address on application.

Address all communications, not to individual officers, but to the

EXPERIMENT STATION, BURLINGTON, VT.

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OF BULLETINS 96-99, PAGES 1-136, PUBLISHED DURING THE YEAR BUT NOT INCLUDED IN THIS VOLUME

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OF SIXTEENTH ANNUAL REPORT

FINANCIAL REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1903

Vermont Agricultural Experiment Station, in account with the United States Appropriation, 1902-1903.

DR.

To receipts from the Treasurer of the United States as per appropriation for fiscal year ending June 30, 1903, as per act of Congress approved March 2, 1887	$15,000 00

CR.

	Abstract		
By Salaries	1	$6,682 23	
" Labor	2	2,775 78	
" Publications	3	799 13	
" Postage and stationery	4	465 19	
" Freight and express	5	66 95	
" Heat, light and water	6	442 74	
" Chemical supplies	7	287 27	
" Seeds, plants and sundry supplies	8	141 10	
" Fertilizers	9	75 61	
" Feeding stuffs	10	1,178 24	
" Library	11	99 00	
" Tools, implements and machinery	12	104 63	
" Furniture and fixtures	13	127 35	
" Scientific apparatus	14	409 51	
" Live stock	15	......	
" Traveling expenses	16	478 83	
" Contingent expenses	17	116 44	
" Building and repairs	18	750 00	
			$15,000 00

We, the undersigned, duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the Vermont Agricultural Experiment Station for the fiscal year ending June 30, 1903, that we have found the same well kept and classified as above, and that the receipts for the year from the treasurer of the United States are shown to have been $15,000, and the corresponding disbursements $15,000, for all of which proper vouchers are on file and have been by us examined and found correct.

And we further certify that the expenditures have been solely for the purposes set forth in the act of Congress approved March 2, 1887.

Signed,

{SEAL}

MATTHEW H. BUCKHAM,
CASSIUS PECK,
GARDNER S. FASSETT, } Auditors.

Attest,

E. HENRY POWELL,
Custodian.

Receipts and disbursements under No. 83 of the Acts of 1902 (fertilizer law); No. 83 of the Acts of 1898 (feeding stuffs law, repealed December, 1902); No. 84 of the Acts of 1902 (feeding stuffs law); No. 81 of the Acts of 1898 (creamery inspection law); for the fiscal year ending June 30, 1903.

DR.

A.	To license fees received from fertilizer companies and forwarded to State treasurer		$2,290 00
B.	To funds received July 1, 1902,-Jan. 3, 1903, from sale of inspection tags for feeding stuffs and forwarded to State treasurer ($195.01), plus balance last report ($168.79)		363 80
C.	To State appropriation for feeding stuff inspection....		500 00
D.	To balance on hand last report	$ 6 26	
	To receipts from applicants for licenses	47 00	
	To receipts from supply houses, creameries and cheese factories for testing Babcock glassware	163 25	
			$216 51

CR.

	A	B	C	D
By Salaries..........................	$650 00	$108 00	$.........	$.........
" Labor..........................	79 66	12 83†	....	186 22
" Publications..........................	669 81	118 76	....	....
" Postage and stationery..........	21 56	17 60†	4 75	2 56
" Freight and express..............	15 25	10 06	7 70	1 55
" Heat, light and water............	43 51	5 00	....	....
" Chemical supplies................	223 45	24 66	....	....
" Sundry supplies..................	....	....	....	10 69
" Traveling and sampling expenses	422 91	17 70	78 54	....
" Contingent expenses	....	*48 97	....	‡6 49
" Building and repairs	36 15			
Add amounts forwarded to State treasurer against which no expenditures have been incurred prior to July 1, 1903...	127 70	0 22		
Add amount not drawn upon June 30, 1903......................			409 01	
Add balance on hand unexpended				9 00
	$2290 00	$363 80	$500 00	$216 51

* Inspection tax tags. † Including $7.80 omission in account of a previous year. ‡ Including $2.00 returned to applicants to whom licenses were refused.

REPORT OF THE DIRECTOR

J. L. Hills

The present report covers the work of the Station during the past fiscal year, July 1, 1902, to June 30, 1903. The bulletins issued during that time, Nos. 96 to 99 inclusive, as well as the annual report, are both indexed in the latter.

PUBLICATIONS

Four bulletins and the fifteenth annual report, aggregating 334 pages of printed matter have been issued during the year in editions of 12,000 to 12,500. Abstracts of the regular bulletins appear on pages 150-152. A list of publications issued during the year follows:

1902.

September, No. 96. Apple pomace a good feed for cows, 8 pages.

September, No. 97. Analyses of commercial feeding stuffs, 16 pages.

Fifteenth annual report, 198 pages.

1903.

March, No. 98. Analyses of commercial fertilizers, 24 pages.

May, No. 99. Commercial fertilizers, 88 pages.

Many of the back bulletins and reports of the Station are nearly or quite out of print. Parties having spare copies of any of the publications noted in the following list would confer a favor by returning the same to the Station, thus enabling it to comply with requests from libraries and from other Stations. Postage will be refunded to the sender on request.

All of the Station reports except the 3d, 13th, 14th and 15th; Bulletins 1 *to* 11 *inclusive*, 15, 16, 19, 20, 22, 25, 28 *to* 34 *inclusive*, 36 *to* 40 *inclusive*, 42, 45, 50 *to* 52 *inclusive*, 56, 57, 59 *to* 63 *inclusive*, 65, 69, 71 *to* 75 *inclusive*.

PUBLICATIONS ON HAND

The Station has issued to the date of distributing this report, including the present number 16 annual reports and 105 bulletins. Many of these are out of print. The following numbers are in print, and will be sent on request without charge as long as the supply lasts:

1888, April.	No. 12, Insecticides; seed tests; Miscellaneous analyses	16 pages
November.	No. 13, Methods of cutting and planting potatoes; fertilizer analyses	12 pages
	No. 14, Analyses of fertilizers licensed for sale in the state of Vermont for the year 1888	16 pages
1889, October.	No. 17, Test of dairy cows at Vermont state fair	18 pages
	Third annual report	178 pages
	(Commercial fertilizers, water analyses, feeding trials with cows, fodder crops, horticultural and entomological matter.)	
1890, January.	No. 18, Pig feeding	20 pages
September.	No. 21, A new milk test; testing milk at creameries and cheese factories; notes for the laboratory	32 pages
1891, March.	No. 23, Analyses of fertilizers licensed for sale in the state of Vermont for the year 1891	16 pages
May.	No. 24, Potato blight and rot	16 pages
September.	No. 26, Maple sugar	24 pages
1892, January.	No. 27, Tests of dairy apparatus	12 pages
1893, May.	No. 35, Analyses of fertilizers licensed for sale in the state of Vermont for the year 1893	16 pages
1894, May.	No. 41, Analyses of commercial fertilizers	16 pages
November.	No. 43, Household pests	8 pages
December.	No. 44, Spraying orchards and potato fields	28 pages
1895, March.	No. 46, Analyses of commercial fertilizers	16 pages
May.	No. 47, Commercial fertilizers	40 pages
October.	No. 48, Gluten feeds and meals	20 pages
1896, August.	No. 53, The pollination of plums	20 pages
November.	No. 54, Salad plants and plant salads	16 pages
December.	No. 55, Apple growing in Grand Isle county	16 pages
1897, April.	No. 58, Analyses of commercial fertilizers	16 pages
1898, April.	No. 64, Analyses of commercial fertilizers	16 pages
September.	No. 66, Club-root and black rot of the cabbage	16 pages
December.	No. 67, Hybrid plums	30 pages
1899, January.	No. 68, Inspection of milk tests and feeding stuffs	8 pages
April.	No. 70, Analyses of commercial fertilizers	16 pages
October.	No. 73, The trees of Vermont	54 pages
1900, March.	No. 76, The forest caterpillar	28 pages
April.	No .77, Analyses of commercial fertilizers	24 pages
	No. 78, Analyses of commercial feeding stuffs	24 pages
	No. 79, Analyses of commercial fertilizers	12 pages
May.	No. 80, Analyses of commercial fertilizers	48 pages
September.	No. 81, Principles and practice of stock feeding	56 pages
	No. 82, Analyses of commercial feeding stuffs	26 pages
December.	No. 83, Apples of the Fameuse type	16 pages
1901, January.	No. 84, Analyses of commercial feeding stuffs	16 pages
	No. 85, Potato scab and its treatment	12 pages
March.	No. 86, Analyses of commercial fertilizers	24 pages
	Thirteenth annual report	258 pages

		(Potato diseases, weed killing, bacterial vegetable rots, plum propagation, plum and apple pollination, composition of potatoes and of artichokes, feeding trials with cows, food effect on butter quality, herd records.)	
	May.	No. 87, Analyses of commercial fertilizers	48 pages
	October.	No. 88, Analyses of commercial feeding stuffs	16 pages
	November.	No. 89, Plum culture	12 pages
	December.	No. 90, Apple growing in Addison county	8 pages
1902.		Fourteenth annual report	234 pages
		(Potato diseases, apple rots, grasses, weed killing, plum propagation, hybrid plums, apple inventory of Grand Isle county, nitrogen free extract matter of potatoes and of artichokes, organic nitrogen availability, testing Babcock glassware, feeding trials with cows, comparisons of feeding trial methods, food effect on butter quality.)	
	February.	No. 91, Analyses of commercial feeding stuffs	16 pages
	April.	No. 92, Analyses of commercial fertilizers	24 pages
	May.	No. 93, Commercial fertilizers	54 pages
	May.	No. 94, Vermont grasses and clovers	48 pages
	June.	No. 95, A poisonous plant—the common horsetail	8 pages
	September.	No. 96, Apple pomace a good feed for cows	8 pages
	September.	No. 97, Analyses of commercial feeding stuffs	16 pages
1903.		Fifteenth annual report	198 pages
		(Potato diseases, orchard diseases, locust trees, weed killing, propagation of plums, Americana plums, Japanese hybrid plums, feeding trials with cows, comparisons of feeding trial methods, herd records, score-card vs. performance of cows, food effect on butter, barn and pasture feeding.)	
	March.	No. 98, Analyses of commercial fertilizers	24 pages
	May.	No. 99, Commercial fertilizers	88 pages
	August.	No. 100, Paying for separator cream at creameries	24 pages
	September.	No. 101, Commercial feeding stuffs	8 pages
	October.	No. 102, The measurement of saw logs	8 pages
	December.	No. 103, The maple sap flow	160 pages
	December.	No. 104, Commercial feeding stuffs	8 pages
1904.			
	February.	No. 105, The maple sap flow	32 pages

CHANGES IN THE STATION STAFF

Prof. F. A. Waugh, who since 1896 had been horticulturist of the Station and professor of horticulture in the University, resigned those offices on September first to accept similar positions at the Massachusetts Agricultural College. William Stuart, a graduate of the agricultural department of this University in 1894, and M. S. of Purdue University in 1896, for eight years connected with the Indiana Station as assistant botanist and associate horticulturist, was chosen

to fill both vacancies. B. O. White, Ph. B., a graduate of the University in the class of 1873, and assistant chemist of the Station from its foundation, resigned October 1st. F. M. Hollister, B. S., a graduate of the agricultural department of the class of 1903, was chosen to fill the vacancy upon his graduation. W. J. Morse, a graduate of the agricultural department of the University in 1898, and M. S. of the same in 1903, was chosen assistant botanist in the place of A. W. Edson, A. B., resigned before the opening of the fiscal year.

RELATION OF THE STATION TO THE PUBLIC

The Station seeks to promote the agricultural interests of Vermont in a five-fold manner:

1. By the scientific investigation of matters pertaining to agriculture and the publication of the results of its experimental work in the form of bulletins and reports, and also through the medium of the agricultural, scientific and general press.

2. By sampling, analyzing and reporting the quality of the sundry commercial fertilizers, feeding stuffs, etc., sold in Vermont, and by supervising certain matters relating to the conduct of the milk-test system at creameries and cheese factories.

3. By direct correspondence with individuals of all classes, particularly with farmers, and by the personal contact of members of the station staff with the farming community at institutes, fairs, through visitation, etc.

4. By analyzing miscellaneous agricultural materials for residents of the state in accordance with section 263 of the Vermont statutes.

5. By so conducting its farming operations that visible and tangible evidence may be shown of the usefulness of science in agriculture; or, in other words, by affording daily object lessons in good modern farming.

1. *Publications.*—The determination and dissemination of new and useful facts of an agricultural bearing is the main function of the Station.

It makes an attempt to reach its constituency in many ways, and it is felt that it is yearly becoming more useful. The passage of an act by the legislature of 1898 appropriating not to exceed one thousand dollars annually for printing the report permits of a larger use of printer's ink than heretofore. For instance bulletins 81 on the "Principles and Practice of Stock Feeding" and 94 on "Vermont Grasses and Clovers" could hardly have been issued had it

not been for this fund. The sum is a fair offset against expenses incurred in complying with section 263 V. S.

2. *Inspection work.*—This line of work is conducted in accordance with state laws similar to those in other states and serves in some degree to put the traffic in commercial fertilizers and feeding stuffs and the milk-testing practice of creameries and cheese factories on a higher plane.

3. *Correspondence.*—This class of work continues to make considerable inroads upon the time of the director and of other members of the staff. It is, however, a legitimate line of service, which is helpful to the farmer, and is gladly undertaken. The personal contact of station workers with farmers is to be encouraged. In a few ways can the results of station endeavors be brought home more directly to the farmer, or his needs and perplexities be more clearly realized by the scientist than by their meeting at the institute, in the field or by visitation. The director was an active member of the State board of agriculture for fourteen years and station representatives address from 20 to 40 farmers' institutes annually.

4. *Miscellaneous analytical work.*—Section 263 of the Vermont statutes requires the Station to analyze materials of an agricultural nature without charge to the citizens of Vermont. Parties intending to make use of the Station in this way are respectively referred to the supplements in the announcement on page 139. Attention is called to the fact that the Station no longer makes water analyses, a class of work now done at the laboratory of the State board of health. Mineral analyses, human food analyses (other than milk and milk products), the investigation of cases of suspected poisoning, etc., are likewise outside its province. Questions concerning mineral resources should be sent to the State geologist, Prof. G. H. Perkins, Burlington; those having to do with poisoning should be referred to the State's attorney of the county in which the alleged poisoning occurred. Analyses of human food are made in the laboratory of the State board of health at Burlington.

5. *The station farm.*—The farm and buildings are open to the inspection of all who may be interested therein. Visitors are welcome on week days to look over the buildings and stock. The kindly words of approval from thousands of visitors in the past show that the object lessons in good farming, the experiments which appeal to the eye, and the information elicited by direct questioning of those in charge alike prove helpful.

RELATION OF THE STATION TO THE STATE

The income of the Station is derived from several sources, including the congressional grant, state printing appropriation, license fees from commercial fertilizer companies, appropriation for feeding stuffs inspection, creamery glassware and operators' fees, and sale of farm produce. The financial reports showing the expenditures of several of these funds are printed on pages 142-143. It is to be noted that the State laws require the Station to do a class of work, which, while unquestionably of much value to the farming interests, is held by the government officials to be outside the province of the national enactment. Hence it is that the funds derived from the congressional grant cannot be used for such purposes and recourse must be had to other means of income.

WORK OF THE YEAR

Full statements of the main results of station endeavor during the past year published in this report (not in bulletins) in the departments of botany, horticulture, chemistry, and dairy husbandry are made under appropriate headings in the following pages.

Copies of the bulletins abstracted in the following pages will be sent without charge to any address on application.

ABSTRACTS OF BULLETINS

BULLETIN 96: APPLE POMACE A GOOD FEED FOR COWS

By J. L. Hills

The excessive rains and cool weather of the growing season of 1902 seriously curtailed the corn crop. A large proportion of the total crop failed to mature. It is suggested that apple pomace be ensiled and fed as a supplement to corn silage or corn fodder.

The experience of four years with apple pomace silage at this Station, using over twenty cows, is a unit in affirming the nearly equivalent—if not, indeed, quite equivalent—feeding values of apple pomace and corn silage. No undesirable results whatsoever have followed its use. Cows continuously and heartily fed have not shrunk, but on the contrary have held up their milk flows remarkably well. Neither does the milk nor the butter seem injured in any respect. Inasmuch, however, as reports of severe shrinkage occurring coincident with the use of apple pomace are current, care is advised in feeding it at the outset.

Apple pomace needs no special care in ensiling. If levelled from time to time as put into the silo and left to itself uncovered and nuweighted it does well. Fifteen pounds a day per cow has been fed at this Station with entire satisfaction.[1]

BULLETIN 97: ANALYSES OF COMMERCIAL FEEDING STUFFS

By J. L. Hills, C. H. Jones and B. O. White

Two hundred and eighteen samples collected in March and April 1902, have been analyzed. No adulteration was found in the linseed or gluten brands, although, as heretofore, the Chicago, King, Davenport, Pekin and Glen Cove gluten products, as well as the germ oil meal, failed to meet the guaranty statements. The cottonseed meals were unadulterated, but several of them were short in protein. The Cremo brand of cottonseed feed meal, a mixture, probably, of meal and hulls, guaranteed to carry 25 percent protein, actually furnished but from one-half to two-thirds this quantity. It sold at but four dollars

[1] See page 254 for further data on trials in which thirty-five pounds daily were fed.

less than the regular meals, but furnished hardly more than a third as much protein. It is a very costly feed of doubtful feeding value.

The better grades of oat feeds, corn and oat feeds, etc., were found as usual to meet the claims made for them by the manufacturers. The poorer grades—likewise as usual—were of lower grade than even their small promises indicated.

Ninety percent or thereabouts of the provenders (other than the output of the oatmeal mills) seem to be above reproach. Ten percent were more or less open to question, while a few were almost surely laden with extraneous hulls.

No adulteration was found among the wheat products, although one mixed feed seems somewhat suspicious. Inasmuch, however, as several adulterants are vigorously pushed by the jobbing trade and sales to the Vermont trade attempted, buyers will do well to scan purchases with more than ordinary care.

BULLETINS 98 AND 99: COMMERCIAL FERTILIZERS[1]

By J. L. HILLS and C. H. JONES

Results of inspection.—The Station drew from dealers' stocks in the spring of 1903 and analyzed 111 of the 114 licensed brands, the output of nine companies, all 1903 goods.

Quantity of plant food.—Ninety-six percent of the brands met their guaranties and none failed to afford a commercial equivalent thereof. The average fertilizer carried ten percent more plant food than it was said to contain. Its composition seems to be a little poorer in 1903 than it was in 1902, but this probably a seeming rather than a real difference.

Quality of plant food.—The quality of the crude stock used was found to be as a rule above reproach. A few criticisms however may be made. A third of the brands, mostly the low grade and low priced goods, carried no water-soluble nitrogen. An inferential claim, that sulphate of potash was used, appears on five-sixths of the brands; it was actually used in less than one-sixth of them. The organic nitrogen used by two companies seems to be of low grade and its use-

[1]No. 99 is not an ordinary fertilizer bulletin dealing mostly with analyses, but contains a somewhat full survey of sundry matters about the use of fertilizers, being the first of a series designed to furnish a fairly complete treatise on this subject. Scientific terms have been avoided so far as it was possible to do so. It contains an index and a dictionary of terms. If you use fertilizers, send for it, keep it, and get the issues of succeeding years.

fulness may well be doubted. This condition has been met for some years in the goods of one of these companies.

Selling prices and valuations.—The average selling price was $28.25, the average valuation, $18.59. One dollar in three spent for mixed fertilizers was paid to the manufacturer, railroad, and selling agent for their work, while only two of the three paid for plant food. But 60 cents worth of plant food was bought for a dollar in average low grade goods, and 64 cents worth in medium grade goods. The average high grade brand, however, afforded 73 cents worth for a dollar. Some Vermont buyers paid twice as much for plant food as did others. He who employs thought and gumption may save money in fertilizer buying.

Vermont's fertilizer bill.—Vermont uses half a million dollars worth of commercial fertilizers annually. The "east-side" uses three-fifths of this amount. The fertile Champlain valley soil and the more intense dairy husbandry of the "west-side" are probably factors in this matter. Vermont spends less for commercial fertilizer per improved acre than any other state from Maine to Florida except West Virginia.

Concerning fertilizer buying it may be said that *guaranties* should be closely scanned lest one be misled; that *brand names* may or may not mean much; that *valuations* show retail cash-cost of equivalent amounts of plant food of good quality—only this and nothing more; that *agricultural values* and *commercial values* are utterly unlike and entirely distinct one from the other; and that often the *form* the plant food is in is as important as the amount that is present.

Nitrogen, available phosphoric acid, potash and lime are—with humus and moisture—the essential soil constituents which force crop growth. A clear understanding of their nature and functions ought to be of service in buying plant food.

The analyses of the fertilizers sold in Vermont in 1903 appear on pages 109-117 of the bulletin.

The comparison of analyses of brands for five years shows in some cases essential evenness and in others considerable variation in composition. The tables showing composition for five years should prove helpful to the early buyer of mixed goods.

A glossary or dictionary of the terms used in the bulletins which seem in the least open to misunderstanding, or which are apt to be obscure to any reader, will be found on pages 126-132, *a table of contents* on pages 51-52, and *an index* on pages 133-135 of bulletin 99.

REPORT OF THE BOTANISTS

L. R. Jones and W. J. Morse

The general policy of the work in the botanical department remains unchanged. Plant diseases and their remedies continue to occupy the first place among the detailed investigations. At the same time an interest is maintained in other botanical problems that relate to agricultural science. Observations and experiments have accordingly been continued upon economic grasses and clovers and upon the weed plants of the state. Co-operative work has been undertaken with the United States Department of Agriculture along three lines of a considerable practical as well as scientific interest, namely, forestry, the cultivation of drug plants, and the inspection of grass and clover seeds.

The subjects which are in such condition as to justify detailed report upon them are as follows:

- Occurrence of plant diseases in Vermont in 1903.
- Potato diseases and their remedies.
  - Results from spraying potatoes.
  - Relation of date of digging to the development of rot.
  - Does liming prevent rot?
  - Potato scab experiments.
- Notes on certain threatening weeds.
- The shrubby cinquefoil as a weed.

OCCURRENCE OF PLANT DISEASES IN VERMONT IN 1903

WEATHER CONDITIONS

The summer of 1903 was an unusual one. From the middle of April to the first week of June there was no rainfall at Burlington and a similar condition of drought existed throughout the northeastern section of the country from Maine to the Potomac. This was followed by unusually copious rains and cool, cloudy weather during July and August. The effect of the weather conditions as regards pathological conditions of plants was shown in various ways. Most insect pests were less troublesome than usual. This was true, for example, of both the Colorado potato beetle and the flea beetle. The fungi which make their chief headway in the spring, such as apple scab, were also less troublesome than usual. On the other hand, certain physiological diseases were unusually prevalent as a result of the abnormal weather conditions.

POTATO BLIGHTS

Few potatoes made much growth until the rains came in June. They then developed with unusual rapidity. This vigorous growth coupled with the absence of insects already noted, gave a fine stand of tops by the middle of August. Less arsenical poisoning than usual was noted because less of paris green and similar insecticides were used. The late development of the plants, coupled with the climatic conditions, led to little tip burn. The early blight did little damage about Burlington up to September first, except on the light sandy soils. On such it was serious by August first and increased rapidly thereafter. The late blight fungus was also tardy in appearing, being fully three weeks later than last year. The first blighting leaves were found about August 10 in 1903. The malady spread gradually during August. Some pieces of potatoes on sandy soil escaped entirely, but practically every field about Burlington, other than these, was badly blighted before September first. The resultant rot was naturally general and severe.

Early sprayings with insecticides or fungicides alike profited less than usual. This outcome is in marked contrast with that of last year, when an unusually early application was needed. This will doubtless tend to discourage some who, through lack of experience, sprayed too late in 1902 and too early in 1903. It emphasizes again the importance of learning to recognize the maladies to be controlled. As shown in the discussion of the spraying experiments (page 157), a single thorough spraying given at the right time was a sufficient protection.

ORCHARD DISEASES

There was practically no loss from apple and pear scab even on the more susceptible varieties, such as Fameuse apples and Flemish beauty pears. This was true regardless of whether the trees were sprayed or not.

The weather conditions caused some russeting of the skin of apples. This was more evident on the sprayed than on the unsprayed fruit, although occurring on the latter. Frost bands were conspicuous upon apples in many parts of the state. This development of a band of russeted skin upon the otherwise smooth fruit is caused by a touch of frost just after the fruit set.[1] Such russeting of fruit, whether a result of climatic conditions or of spraying, injures neither its keeping quality nor its flavor.

[1] See discussion of frost bands on apples and pears, Vt. Sta. Rpt. 9, p. 104 (1895).

The bacterial disease pear blight was also less prevalent than usual on pears, and no twig blight was observed on plum trees. The brown rot of plums also caused but little destruction.

GARDEN VEGETABLES

A soft rot of turnip developed badly in the station garden where several varieties were grown. This is a bacterial disease similar in cause and character to the bacterial soft rot of carrot. The organism which causes it is being studied at present at this Station.

Club rot of cabbage, turnips, etc., was reported from certain localities. It is apparently becoming widespread in the State. Onion mildew was again destructive in those sections where onions are grown as a field crop. The remedies for both these maladies have been discussed previously.[1]

POTATO DISEASES AND THEIR REMEDIES

I. THE RESULTS FROM SPRAYING POTATOES IN 1903

1. GAINS FROM USE OF BORDEAUX MIXTURE

Experimental sprayings of potatoes with fungicides and other compounds have been conducted at this Station each summer for fourteen years. During this time a large number of preparations have been tested and nothing equal to bordeaux-arsenical mixture has been found for use in the latter part of the season. The gains from the right use of this mixture have been large on the average and are chiefly attributable to the prolongation of the life of the foliage into the autumn, through protecting it from both fungus and insect ravages. In general two applications of the mixture have proved most profitable. Owing, however, to the late appearance of the blight in 1903, and the fact that its development was checked by continuous dry weather in early September, a single application of the mixture, about the tenth of August, proved sufficient for the preservation of most of the foliage from blight. On heavy soil there was some rot where the plants were sprayed only once, but the crop in the main field of the station farm, which was a sandy loam, three and one-half acres in extent, thus sprayed once, retained its foliage in good shape well through September and yielded over 1200 bushels of marketable potatoes with practically no rot.

No unsprayed rows were left in this field, but in a smaller one on higher but somewhat heavier soil, records were obtained. This field was planted with the Green Mountain variety about May first, and

[1] Vt. Sta. Rpt. 10, p. 61 (1897), mildew; Bul. 66 (1898), club root, etc.

given one thorough application of bordeaux mixture on August 10. As has been previously stated the late blight appeared comparatively late in the season and one application gave practical protection. The plots were dug September 24. The unsprayed tops had been dead for some two weeks, while at least fifty percent of the foliage was still alive on the sprayed tops. The sprayed and unsprayed portions were carefully selected with a view to uniformity. Each lot consisted of four rows fifty-eight feet long. The total yields calculated in bushels to the acre are as follows:

Sprayed, 392 bushels per acre;

Unsprayed, 285 bushels per acre;

This shows an increase in total yield as a result of spraying of 107 bushels per acre.

The records of the amount of decay in the sprayed and the unsprayed plots make the actual gains even greater.

Numbers of bushels per acre of sound tubers in unsprayed plots	361
Number of bushels per acre of decayed tubers in sprayed plots	31
Number of bushels per acre of sound tubers in unsprayed plots	237
Number of bushels per acre of decayed tubers in unsprayed plots	48
Percent of decay in sprayed plots	8
Percent of decay in unsprayed plots	17
Gain per acre of bushels of merchantable potatoes	124

DISCUSSION OF THE RESULTS

This gain was not as large as it has been in seasons when the blight has come earlier and progressed more rapidly. On the other hand under such conditions two or even three sprayings are required to preserve the foliage until the maturing of the crop. The *gain of 124 bushels per acre as the result of a single timely spraying* represents a larger gain in proportion to the cost than we have heretofore recorded. We learned of cases where potato growers sprayed their plants twice this season *in July* and secured but little benefit for the simple reason that by the time the blight was destructive, the latter half of August, their plants were unprotected. Our experience again serves to emphasize sharply the point we have repeatedly made, that *in order to spray most profitably a man must know what he is spraying for, watch his crop and spray intelligently as well as thoroughly.* To paraphrase the old saying, a spray in time saves the crop. *Timeliness* is an important factor in success. That it pays richly to use *thoughtfulness, thoroughness* and *timeliness* may be judged from the cumulative data showing the results from thirteen consecutive season's work at this Station. These figures speak for themselves.

GAINS FROM USE OF BORDEAUX MIXTURE ON LATE POTATOES.

Variety	Planted	Sprayed	Yield per acre: Where sprayed	Yield per acre: Whe'e not sprayed	Gain per acre
White Star...	May 11, 1891.	Aug. 26, Sept. 3.........	313 bu.	248 bu.	65 bu.
" " ...	May 20, 1892.	July 30, Aug. 13, 25......	291 bu.	99 bu.	192 bu.
" " ...	May 20, 1893.	Aug. 1, 16, 29............	338 bu.	114 bu.	224 bu.
" " ...	Apr. 26, 1894.	June 16, July 17, Aug. 30	328 bu.	251 bu.	77 bu.
" " ...	May 20, 1895.	July 25, Aug. 13, 31......	389 bu.	219 bu.	170 bu.
Polaris........	May 15, 1896.	Aug. 7, 21................	325 bu.	257 bu.	68 bu.
"	June 1, 1897.	July 27, Aug. 17, 28......	151 bu.	80 bu.	71 bu.
White Star...	May 10, 1898.	July 21, Aug. 10.........	238 bu.	112 bu.	126 bu.
Average 3 var.	May 18, 1899.	July 26, Aug. 17, Sept. 8	229 bu.	161 bu.	68 bu.
Delaware	May 23, 1900.	Aug. 4, 23................	285 bu.	225 bu.	60 bu.
"	May 25, 1901.	July 20, Aug. 21.........	170 bu.	54 bu.	116 bu.
"	May 15, 1902.	Aug. 1, 20................	298 bu.	164 bu.	134 bu.
Green Mount.	May 1, 1903.	Aug. 10..................	361 bu.	237 bu.	124 bu.
Averages for thirteen years.................			286 bu.	171 bu.	115 bu.

2. ADDITIONS OF BUG DEATH AND PARIS GREEN TO BORDEAUX MIXTURE

This experiment was conducted in a field belonging to the Mary Fletcher hospital. Its object was to determine the relative efficiencies of bug death and paris green when used alone and with bordeaux mixture in the latter part of the season.

The soil was a somewhat sandy loam, one which, as a general thing, produces large crops of potatoes in this vicinity if properly fertilized and if fungi and insects are kept off so that the plants are able to reach maturity. With the exception of a few depressed, slightly moist areas, the soil conditions of the field, consisting of about three acres, were quite uniform.

The plots selected were on a slight rise, and the plants over the entire area were uniform in size and condition on the first of August, when the experimental sprayings were begun. They had received one application of dry paris green about a month or more before, which had sufficed to keep them fairly free from the Colorado beetle, although the effects of this had disappeared. The foliage was entirely healthy, showing no early or late blight, and no paris green poisoning on the leaves. There were, however, quite a number of young and a few old Colorado beetles on each row. On July 20, twenty-four rows, each forty-five feet long, were staked out, and sub-divided into three plots of eight rows each. On August 3 these were treated as follows:

Rows 1, 9, 17, paris green in water.

Rows 2, 10, 18, check, untreated.

Rows 3, 11, 19, bordeaux-paris green mixture.

Rows 4, 12, 20, bordeaux-paris green mixture.

Rows 5, 13, 21, bordeaux-bug death mixture.
Rows 6, 14, 22, bordeaux-bug death mixture.
Rows 7, 15, 23, bug death applied dry.
Rows 8, 16, 24, bug death applied dry.

METHODS OF PREPARING AND APPLYING THE MATERIALS USED

Paris green.—One-half pound of paris green was used to forty gallons of water, and enough freshly slaked lime was added to give the mixture a decidedly white color. The paris green and the lime in the form of a thick whitewash were first mixed together and allowed to stand sometime before adding to the water.

Bordeaux-paris green mixture.—This was prepared according to the standard formula (6 lbs. copper sulphate, 4 lbs. fresh stone lime, 40 gallons water, ½ lb. paris green). The lime was slaked and diluted with one-half of the water, the copper sulphate dissolved in the other half and the two dilute solutions poured at the same time into a third vessel, the mixture being constantly stirred.

Bordeaux-bug death mixture.—This was prepared as recommended by the manufacturers of "bug death." The process is essentially the same as has been described above, except that bug death was added to the copper sulphate solution at the rate of twelve and one-half pounds to forty gallons of water before mixing with the dilute lime solution.

Bug death dry.—This was applied to the tops at the rate of fifty pounds per acre, by shaking through a cloth bag furnished by the manufacturers with the compound.

The liquid preparations were applied by means of a knapsack sprayer, care being taken to spray all the foliage thoroughly. Consequently the amount of bug death applied in the bordeaux-bug death mixture was over twice as much per acre as that where bug death was applied dry.

In six days, August 9, all the sprayed rows alike were free from the Colorado beetles, except for occasionally mature insects, whereas there were about as many on the check rows as there were at the time of spraying.

On August 16 there appeared to be very little change from the condition noted the week before.

The record on August 28 (nearly four weeks from spraying), was as follows:

Paris green in water: Yellowing with blight and insect injuries. (Row 9 better than 1 or 17.)

Untreated: Same as above. (Row 10 better than 2 or 18.)

Bordeaux-paris green: Excellent condition.

Bordeaux-bug death: Excellent condition.

Bug death applied dry: Considerable blight and yellowing of leaves.

Ten days later (September 7) the stalks were still green but the foliage was entirely dead on the check rows as well as on those rows treated with paris green, and bug death dry, with the exception of rows 23-24 (bug death), where about twenty-five percent of the leaves were still green. The remaining rows (bordeaux and insecticides) were still green, at least ninety percent of the leaves being healthy, though the effects of both early and late blight could be found on these rows.

A week later (September 14) the rows sprayed with bordeaux-paris green and bordeaux-bug death still showed from fifty to seventy-five percent green leaves. No great difference could be observed between them. The tops on the remaining rows were entirely dead.

The plots were dug on October 7th (two months after spraying), when the tops on all the rows were entirely dead, with an occasional exception where bordeaux mixture had been used. The following gives the treatment and the yield from each treatment (three rows), in pounds:

Treatment.	Yield, 3 rows.
Paris green	220 pounds.
Control (untreated)	241 "
Bordeaux-paris green mixture	278 "
Bordeaux-bug death mixture	280 "
Bug death applied dry	237 "

DISCUSSION OF THE RESULTS

The data displayed in the foregoing table correspond fairly well to the differences as judged from the appearance of the foliage before digging. It will be seen that the paris green, bug death and untreated rows average much alike. Owing to one row where soil conditions proved unfavorable the product of the paris green rows dropped below the others. Doubtless the fact that the untreated rows yielded slightly more than either the bug death or paris green is again due to slight inequalities in soil. The only conclusion which seems justified is that the climatic conditions of 1903 growing period were so unusual that there were very few insects on the potato plant and, hence, that neither of these insecticidal treatments was required nor did any appreciable good. Practically all of the damage in this field after the experimental spraying of early August, was due to the late blight of the foliage. This

is a fungus disease and neither paris green nor bug death are fungicides. The results of our trials of two years ago[1] showed that bug death, while it has value in checking insect ravages, was not effective as against the late blight. The results of the present trial are fully in accord with this observation.

It should be clearly stated, in justice to its manufacturers, that they do not advertise it as a fungicide. But many farmers fail to discriminate in this respect and think of this compound as of possible value in controlling the fungus diseases. The manufacturers advise that bug death be added to bordeaux mixture at the rate of from seven to fifteen pounds to the barrel (fifty gallons). Inasmuch as this is a heavy addition, making the cost for the bug death more than for the bordeaux mixture, it is important to decide whether the value of the combination is increased proportionally to its increased cost. We have always added paris green or similar arsenical poison to bordeaux mixture, even in the late summer. As a matter of fact, it is doubtful whether it is needed unless the insects are unusually prevalent. The amount of this poison used is so small in any case as to make the cost a trifling matter, and, since the presence of the lime in this mixture prevents any possibility of arsenical poisoning, we have continued its use in all cases.

It is evident from the figures, as it was from the foliage before digging, that both of these bordeaux compounds were entirely satisfactory and practically alike in their results. It is believed that the outcome would have been the same had simple bordeaux without any insecticide been used in lieu of bordeaux alone, since this wards off most insects. This seems the more probable in view of the fact that in the other series where no bordeaux was used, the results were practically alike. Of course benefits might have come from the addition of either paris green or bug death had insects proved serious.

The conclusions warranted by the results thus far discussed seem to be as follows:

(1) Neither paris green nor bug death used alone have value in checking the late blight, even where, in the case of bug death, very liberal application is made.

(2) So far as controlling late blight is concerned, bordeaux-bug death mixture and bordeaux-paris green mixture are both efficacious, the one as good as the other, and doubtless simple bordeaux mixture without any insecticide added would prove as good as either.

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[1] Vt. Sta. Rpt. 13, p. 271 (1900).

To avoid being misunderstood, we will repeat what we have stated in previous years,[1] that it is outside of the plans of these experiments to inquire closely into the insecticidal value of bug death. We have, however, seen evidence[1] that it has such value in trials of former years. This year in the absence of insects this factor did not enter into the results.

II. RELATIONS OF DATE OF DIGGING TO DEVELOPMENT OF ROT

"How soon after the tops begin to die from the late blight should the potatoes be dug?" This question is of much practical importance and we undertook in 1902 to secure an answer.[2] Although the results obtained in those trials appeared definite and justified a tentative deduction, it was felt that conditions might so vary from year to year that further trials were needed. Accordingly on August 31, twenty rows of potatoes, forty-five feet long, were staked off on a field belonging to the Mary Fletcher hospital. These were on rather low ground in slightly moist and somewhat sandy soil. The late blight was abundant over the entire field, although it had mostly developed within the preceding week. On the plot selected one-third to one-half of the foliage had been killed during this week by late blight.

Four rows were dug on each of five different dates, at intervals of one week, in such a manner as to give each time as near as possible an average of the plot. The following record shows the date of digging of each row and the condition of the tops at the time.

August 31. Rows 1, 6, 11, 16: foliage from one-third to one-half killed with late blight.

September 7. Rows 2, 7, 12, 17: leaves all dead but stalks green.

September 14. Rows 3, 8, 13, 18: stalks practically all dead.

September 21. Rows 4, 9, 14, 19: tops dead.

September 28. Rows 5, 10, 15, 20: tops dead.

Each lot was stored within a few hours after digging in a cool, house cellar, where the temperature was uniformly 55°-60° F. The tubers were placed in bushel boxes, stacked up so as to allow free ventilation. The yield from each row was divided into two equal parts, one of which was used in the liming experiments (pages 163-165), inasmuch as there was practically no difference in the amount of rot in the limed and unlimed potatoes dug at different dates (see pages 163 165), it is allowable to include the results attained with both the limed and the unlimed tubers in the present discussion.

[1] Vt. Sta. Rpt. 13, p. 271 (1900).

[2] Vt. Sta. Rpt. 15, p. 219 (1902).

When each lot was dug they were carefully sorted and the weight of decayed tubers recorded. Those in storage were sorted on each date of digging, beginning September 7 and ending September 28.

The following table shows the weight of the tubers from each row when dug, the amount of decay when dug, the amount of decay at each sorting and the final weight of sound tubers on September 28.

Row	Date of digging	Total weight	Pounds decayed Aug. 31	Pounds decayed Sept. 7	Pounds decayed Sept. 14	Pounds decayed Sept. 21	Pounds decayed Sept. 28	Total pounds decayed to Sept. 28	Total pounds sound on Sept. 28
1	Aug. 31	46.5	0.	0.	0.	6.5	0.	6.5	40.5
6	" "	44.5	1.5	1.0	9.2	19.6	2.0	34.3	10.2
11	" "	51.7	0.7	0.8	4.5	21.7	5.8	33.5	18.2
16	" "	60.0	1.0	1.0	5.4	20.4	9.9	37.7	22.3
2	Sept. 7	42.0		1.6	0.7	3.0	2.0	7.3	34.7
7	" "	62.5		2.5	0.4	7.4	6.7	17.0	45.5
12	" "	49.0		4.0	0.9	3.1	5.8	13.8	35.2
17	" "	66.0		1.0	0.6	9.0	7.6	18.2	47.8
3	Sept. 14	54.6			4.5	3.8	1.5	9.8	44.8
8	" "	56.7			2.4	1.5	0.5	4.4	52.3
13	" "	59.4			4.2	0.9	3.8	8.9	50.5
18	" "	49.6			6.6	0.7	5.0	12.3	37.3
4	Sept. 21	61.2				8.1	1.5	9.6	51.6
9*	" "	38.4				3.2	0.	3.2	35.2
14	" "	66.5				6.5	0.	6.5	60.0
19	" "	50.2				3.7	2.0	5.7	44.5
5	Sept. 28	52.5					7.0	7.0	45.5
10	" "	59.3					1.0	1.0	58.3
15	" "	44.0					4.5	4.5	39.5
20	" "	45.5					2.5	2.5	43.0

The results are more clearly set forth in the following averages taken from the above table.

The average total weight obtained per row at each digging:

When dug	Aug. 31	Sept. 7	Sept. 14	Sept. 21	Sept. 28
Weight, pounds	50.6	54.9	55.1	54.2	50.3

Average weight of potatoes from each digging which were sound on September 28:

Date of digging	Aug. 31	Sept. 7	Sept. 14	Sept. 21	Sept. 28
Weight, pounds	22.8	40.8	46.2	47.8	46.6

Average decay per row previous to September 28:

Date of digging	Aug. 31	Sept. 7	Sept. 14	Sept. 21	Sept. 28
Pounds decayed	28.0	14.1	8.7	6.2	3.7
Percent decayed	55.3	25.7	15.8	11.4	7.3

* The low yield was doubtless due to the fact that this row was extremely weedy.

DISCUSSION OF RESULTS

The results of this experiment are entirely in accord with those previously reported.[1] The work this year was confined to one field and one type of soil, but the quantity of tubers used was much larger than that taken from any one field last season. The conditions of storage were better, and probably much better than those in the average farm cellar.

Regardless of the percent of decay during any one period the most important question to be considered is which procedure will give the largest amount of sound tubers in the end. It will be seen that there is very little difference in the results from those dug September 14, 21 and 28, while the digging of September 7 gave about eight-ninths as much, and that of August 31 less than one-half that obtained from the three later dates. The death of a large percent of the foliage occurred between August 31 and September 7, and the entire tops were dead on September 14. Hence the data obtained this year appear to confirm the rule laid down in the former report: "*That where there is danger of rot it is best to delay the digging some ten days or more after the tops die and that a longer delay does no harm.*"[1]

III. DOES LIMING PREVENT ROT?

Many farmers recommend sprinkling potatoes with air-slaked lime when placed in the cellar. This treatment it is claimed reduces the amount of decay in stored tubers. In order to test the efficacy of this treatment, one-half of the yield of each row used in the trial last described (except those dug on September 28), was sprinkled at the rate of about a quarter of a pound of lime to the bushel and placed side by side with the unlimed portion. The nature of the soil, dates of digging and sorting, and condition of foliage at each digging, have already been described.

The following tables gives the detailed comparison of the amount of decay in each row, both limed and unlimed, on the dates of sorting, as well as the totals for each lot on September 28:

[1] Vt. Sta. Rpt. 15, pp. 222-223 (1902).

Row (limed)	Row (untreated)	Date of digging	Weight of sound tubers when dug	Pounds decayed on Sept. 7		Pounds decayed on Sept. 14		Pounds decayed on Sept. 21		Pounds decayed on Sept. 28		Total pounds decayed Sept. 28	Total pounds decayed Sept. 28	Total pounds sound Sept. 28	Total pounds sound Sept. 28
				Limed	Untreated	Limed	Untreated	Limed	Untreated	Limed	Untreated	Limed	Untreated	Limed	Untreated
1		Aug. 31	23.2	0.		0.		2.9		0.					
	1	"	23.2		0.		0.		3.6		0.				
6		"	21.5	0.5		3.5		10.8		1.5					
	6	"	21.5		0.5		5.7		8.8		0.5				
11		"	25.5	0.6		2.8		8.1		4.8					
	11	"	25.5		0.2		1.7		13.6		1.0				
16		"	29.5	0.6		2.2		10.9		4.8					
	16	"	29.5		0.4		3.2		9.5		5.1				
												56.0	53.8	43.7	45.9
2		Sept. 7	20.2			0.7		1.5		1.0					
	2	"	20.2				0.		1.5		1.0				
7		"	30.0			0.3		2.7		3.7					
	7	"	30.0				0.1		4.7		3.0				
12		"	22.5			0.1		0.3		4.2					
	12	"	22.5				0.8		2.8		1.6				
17		"	32.5			0.6		3.8		6.1					
	17	"	32.5				0.		5.2		1.5				
												25.0	22.3	80.2	82.9
3		Sept. 14	25.0					1.6		0.					
	3	"	25.0						2.2		1.5				
8		"	27.1					0.7		0.5					
	8	"	27.1						0.8		0.				
13		"	27.6					0.2		2.0					
	13	"	27.6						0.7		1.8				
18		"	21.5					0.7		1.5					
	18	"	21.5						0.		3.5				
												7.2	9.0	94.0	92.2
4		Sept. 21	26.5							1.5					
	4	"	26.5								0.				
9		"	17.6							0.					
	9	"	17.6								0.				
14		"	30.0							0.					
	14	"	30.0								0.				
19		"	23.2							1.6					
	19	"	23.2								0.4				
												3.1	0.7	94.0	96.4

The following statement combines the results of all the four plots used in the experiment:

Total decay of limed potatoes to September 28..........	91.3
Total decay of untreated potatoes to September 28......	85.8
Total of limed potatoes sound, September 28	311.9
Total of untrated potatoes sound, September 28	317.4
Percent of decay in limed	29
Percent of decay in untreated	27

DISCUSSION OF RESULTS

So far as can be judged from the results of this single experiment there is nothing to be gained by liming, there being but two percent

difference and that in favor of the untreated tubers. Perhaps the most significant comparison can be made from the lot dug August 31, since in that the greatest amount of decay occurred. The unlimed showed nearly 54 percent decay from the date of digging to September 28, while the limed gave over 56 percent decay in the same period.

This trial of one season with only a few bushels of potatoes should not be regarded as conclusive. It does, however, lead us to doubt the value of the practice, the more so because on theoretical grounds we should expect that after the potatoes are in storage no further infection would occur. It is expected to repeat the trial when conditions again favor. Meanwhile the writer would be glad to learn of the experience of any potato growers with liming potatoes, where definite gains were demonstrated.

IV. POTATO SCAB EXPERIMENTS

Experiments in the disinfection of seed potatoes for scab were carried out during the season of 1903, along the lines suggested by the results of previous years. The plots were located on recently cleared pine land, not previously used for cultivated crops, and which, in all probability, was free from scab germs.

Two varieties of seed were used, Delaware and Rural New Yorker No. 2. This seed was selected from the crop grown on the scab plots of 1902. As in the past, two grades of seed were planted, "scabby" and "smooth." Taken as a whole the scabby tubers were so badly diseased as to be unmarketable. The smooth tubers did not show any visible signs of the disease, but they were sorted from the same lots as the scabby seed. Presumedly they carried the scab germs. To make this certain they were rubbed with scabby tubers, and some of the scabby growth was scraped off and sprinkled over the smooth seed.

The seed was planted in four long rows, and these were divided into five plots according to treatment. Between the plots were check rows twenty feet long of another variety which had been previously disinfected with formalin solution.

Treatment.—One peck of scabby and one peck of smooth seed of each of the two varieties was used in each plot. Before disinfecting, the seed tubers for plots II, III, IV and V were first washed to remove all clots of dirt. The bags in which the seed was placed after disinfecting were steamed for one hour under a steam pressure of fifteen pounds. All disinfecting was performed within twenty-four hours before planting. The tubers were treated thus:

Plot I. Formalin solution, 8 ounces in 15 gallons of water; soaked for two hours.

Plot II. Corrosive sublimate solution, 1 ounce[1] in 8 gallons of water; soaked for one and one-half hours.

Plot III. Formaldehyde vapor (seed wet). The washed potatoes were placed while still wet in a copper lined box on open slat shelves so that the vapor could easily come in contact with all sides of the potatoes as in 1902. The scabby seed was placed on the lower and the smooth seed on the upper shelf. The box contained 8.2 cubic feet of space; it was sealed air tight and contained a small hole near the bottom into which was fitted a pipe leading from the distillation apparatus. In 1902, 12 c. c. of formalin was used for distillation. Since no bad effects were noticeable in the germinating qualities of the potatoes thus treated, this amount was increased this season to 25 c. c. for each treatment, or at the rate of over 3000 c. c. (3 quarts) for each 1000 cubic feet of space. This is over twenty times as much as is recommended for disenfecting a sick room.[2]

The process of distillation was as follows: A small coil of one-half inch gas pipe was made and fitted with a removable cap at one end, while a piece of one-fourth inch gas pipe connected into the disinfecting box was attached by a reducing elbow to the other end. When ready for use the cap was removed, the formaldehyde was introduced into the coil and the cap screwed on, graphite being used to make all joints air tight. The coil was then placed on a large gas burner, the burner lighted and the formaldehyde vapor distilled into the box as rapidly as possible.

Plot IV. Formaldehyde vapor (seed dry). In this case the treatment was the same as with plot III, save that the seed was allowed to become thoroughly dry after being washed. The tubers were then placed in the box and disinfected as above.

Plot V. Untreated. The seed was washed to remove the clots of dirt but no disinfecting solution was used.

The following table shows the data obtained:

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[1] Through an error in our last report, this was made to read, "10 ounces in 8 gallons of water," instead of 1 ounce in 8 gallons of water. See Vt. Sta. Rpt. 15, p. 227 (1902).

[2] Vt. Sta. Rpt. 15, p. 227 (1902).

Plot number and variety	Condition of seed	Treatment	Total weight of tubers	Smooth		Scabby			Average percent of scabby potatoes on each plot
				Weight	Number	Weight	Number	Percent	
Plot I									
Delaware	Scabby	Formalin Sol...	138.0	134.9	924	3.1	21	2.2	
"	Smooth	" " ...	129.0	128.8	910	0.2	2	0.2	
R. N. Y.	"	" " ...	112.5	112.0	806	0.5	7	0.9	
"	Scabby	" " ...	102.5	101.5	859	1.0	8	1.0	1.0
Plot II									
Delaware	Scabby	Cor. Sub. Sol...	121.5	118.1	739	3.4	20	2.6	
"	Smooth	" " ...	117.3	116.7	714	0.6	2	0.3	
R. N. Y.	"	" " ...	127.3	127.3	798	0.	0	0.0	
"	Scabby	" " ...	112.8	110.4	825	2.4	14	1.7	1.2
Plot III									
Delaware	Scabby	Formalin vapor (seed wet)	88.5	74.7	571	13.8	101	15.0	
"	Smooth	" "	90.2	84.8	645	5.4	49	7.1	
R. N. Y.	"	" "	123.9	121.5	989	2.4	22	2.3	
"	Scabby	" "	107.0	98.1	748	8.9	70	8.5	7.6
Plot IV									
Delaware	Scabby	Formalin vapor (seed dry)	127.1	124.7	693	2.4	17	2.4	
"	Smooth	" "	127.5	127.4	947	0.1	2	0.2	
R. N. Y.	"	" "	121.9	121.8	840	0.1	2	0.2	
"	Scabby	" "	137.0	135.4	896	1.6	14	1.5	1.1
Plot V									
Delaware	Scabby	Untreated.......	140.9	111.5	708	29.4	225	24.2	
"	Smooth	"	142.2	137.3	913	4.9	29	3.1	
R. N. Y.	"	"	134.7	130.1	907	4.6	39	4.1	
"	Scabby	"	103.5	77.4	617	26.1	200	24.5	13.6

DISCUSSION OF THE RESULTS

As in all previous trials, extending now through several years, corrosive sublimate and formalin have alike proved equally efficient. The aim in introducing them again this season was primarily to secure thereby a standard or basis for comparison. These solutions afford a cheap and eminently satisfactory means whereby the small potato grower may combat scab. For the large grower and the seed dealer who handles hundreds of bushels, a less laborious process is to be desired. It would be so much more economical and satisfactory in such cases to use a gaseous disinfectant that we have for several years been testing various methods looking to this end.

Without reviewing previous results[1] it may be said that they have pointed toward formaldehyde gas as the most promising candidate for favor. This is the standard disinfectant for use in hospitals and sick

[1] Vt. Sta. Rpt. 13, p. 273 (1900); 14, p. 231 (1901); 15, p. 225 (1902).

chambers for the destruction of germ life. Three methods have been tested with the gas. The generation of the gas from the dry pastilles by use of the Schering lamp is a very convenient method and gave good results in 1900, but less satisfactory ones in 1902, possibly due to loss of strength of the tablets used. We therefore in 1901 and 1902 used the more certain method of generating the gas by boiling the liquid formalin. In using this gas for destroying pathogenic bacteria it has been found that moistened surfaces are sterilized more quickly and surely than are dry surfaces. It seemed desirable, therefore, to test both methods with potato scab. This was done in 1903, with the results given above.

It will be seen at once that the dry treatment gave better results than did the wet. This is surprising yet seems perfectly clear from the figures. It is extremely gratifying that this is so, since the wetting of the tubers before fumigation would not be a practicable thing in many cases, whereas the dry process would always be feasible.

We are not yet fully satisfied that this dry fumigation process is equal to the disinfection attained by soaking the seed potatoes in formalin or in corrosive sublimate solution. These processes have been proved reliable by long experience, whereas this fumigation method should still be considered as in the experimental stage. In view of the several years' results, however, and especially of those of the last summer, dealers and large growers who do not consider the soaking process practicable under their conditions, are advised to use the fumigation process providing their storage room will permit it.

The method recommended.—Prepare to close the room as tightly as possible, (of course the smaller the room and the tighter it can be closed the better); place in a seamless kettle the required amount of formalin solution; set this on an alcohol or kerosene stove containing enough fuel to evaporate it fully; light the flame and retire from the room, sealing the door. Leave the room closed for 24 hours or longer. It remains an open question as to the exact amount of formalin needful. For disinfecting sick chambers, 5 oz. to each 1000 cubic feet is recommended. We used more than this and would recommend the use of not less than one pound for that space. Even more than that will not harm the tubers, as shown by our results.

NOTES ON CERTAIN THREATENING WEEDS

The Station considers that one of its duties is to watch for the appearance and spread of weeds new to the State. The worst pests already present in Vermont are usually foreign plants; and possibilities in the direction of these importations are far from being exhausted. The recent extension of the Rutland railroad through Grand Isle county is responsible for the introduction of at least two bad weeds, and has extended the range of others. This emphasizes the important role of the railroad in weed distribution.

KING-DEVIL WEED. (*Hieracium praealtum*)

This plant is closely related to the orange hawkweed and is said to equal it as a pest. It is established as a bad weed in north-eastern New York, in Maine and in south-eastern New Hampshire. A careful but unsuccessful search was made in Vermont for this plant in connection with our earlier studies upon the orange hawkweed. A specimen was brought to the Station in the summer of 1903 by Mrs. Nellie F. Flynn, gathered on the Rutland railroad track near the mouth of the Winooski river, Burlington. The plants found were promptly eradicated. It is to be hoped that it has not seeded or established itself elsewhere in that region. It is so serious a pest that farmers and rail-road section men should strive to keep it out of the State. The plant closely resembles the orange hawkweed, differing chiefly in having slightly smaller flowers of a yellow color.

CREEPING SOW-THISTLE (*Sonchus arvensis*)

This is probably the hardest thistle to eradicate that occurs in grain fields. It is frequent in sections of Canada and is spreading into north-western Vermont, especially in Grand Isle county. This plant, like the king-devil weed, is apparently migrating by way of the rail-roads, but is probably carried in seed oats or other grain as well.

It is a conspicuous plant when in flower, having yellow dandelion-like blossoms, borne on stems, which raise them above the oats or other grain. They are open in July. Its perniciousness as a weed is due to its underground creeping root stocks, which enable it to spread under cultivation as does the Canada thistle and quack-grass. Farmers should be especially careful not to use or distribute for seed purposes oats containing seeds of this plant.

BLUE THISTLE (*Echium vulgare*)

This is an European weed occurring in New York and Canada. Until recently it was practically confined in this State to portions of Bennington and Rutland counties. It has appeared several times of

late years at scattered points along the Rutland and Central Vermont railroads, at Charlotte, Colchester, Burlington and Milton. Like the two plants just described it deserves the attention of both railroad section men and farmers.

Fig. 1. Blue Thistle. (After Fletcher.)

It is worst as a weed in moist rocky pastures. It is easily recognized by its deep blue blossoms about the size of pea blossoms, and its abundant covering of prickly hairs. The latter give it a thistle-like

character, whence its name, for it is not a true thistle. This should not be confused with the chicory or "blue-weed" which has round blue blossoms about the size and character of dandelion blossoms, borne on taller, smooth, much branched stems.

Fig. 2. Prickly Lettuce. (After Dewey.)

RUSSIAN THISTLE (*Salsola tragus*)

This tumble weed which caused so much alarm to the farmers of the north-west some years ago, was found last year in South Hero in an abandoned quarry from which ballast had been taken for the Rutland railroad. The single plant seen had not scattered its seed and, as it was promptly destroyed, it is hoped that it is exterminated. This is cited, however, as another illustration of how the railroads serve as weed highways.

CLOVER DODDER (*Cuscuta*)

The dodders are parasitic plants which twine about clover and other plants and kill them. They resemble tangles of yellowish fibres without leaves or conspicuous blossoms. One or more species have been introduced with clover seed and were sent to us from various localities during the past summer. They should be exterminated promptly whenever seen since they may prove the worst of weed pests of meadows if allowed to become established.

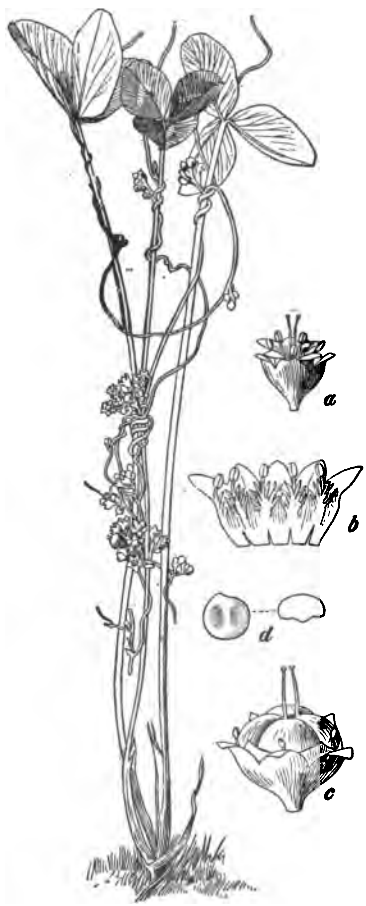

Fig. 3. Clover Dodder. (After Dewey.)

THE PRICKLY LETTUCE (*Lactuca scariola*)

This plant has in recent years come to rival the ragweed as an omnipresent annual in waste places in portions of the northern Mississippi valley. It also seems destined to spread in Vermont along the railroads, since it was first seen on the railroad track at Rouses' Point and, later, in the railroad yards at St. Albans. It has also been seen in waste places in Vergennes and Rutland. It will not prove as serious an intruder as any of the plants previously described, but it is an objectionable visitor which should be kept out at least as long as it can be. It is most easily recognized by the thistle-like appearance and curious habit of its leaves, which bear along the margins and in the mid-rib numerous rather soft prickles and which are usually so twisted at the base as to stand on edge tending toward the north and south plane. It is therefore a "compass-plant," the odd position of the leaves resulting from the influence of sunlight and directing one to the points of the compass.

THE SHRUBBY CINQUEFOIL AS A WEED.

I. INTRODUCTION

Weed problems are always in a measure local problems. Climate, soil and cultural conditions determine largely the character and prevalence of the weeds. We have seen no more striking illustration of this fact than that offered by the plant under discussion. As will be shown in detail later in this article, the shrubby cinquefoil, *Potentilla fruticosa*, is widely distributed in the north temperate zone, but, outside of a few limited areas, it is a botanical rarity. In certain sections, however, including parts of south-western Vermont, it has proved the most aggressive weed invader known to the farmers, taking almost complete possession of the pastures and pushing even into tilled lands. The Experiment station has been appealed to so frequently in regard to this plant that a systematic and fairly exhaustive study of it has been undertaken, with especial reference to its spread as a weed and its control.[1] Certain experiments are under way which will not be

[1] The shrubby cinquefoil has been an object of attention by the botanical department of this Station for several years. During 1902-03 Mr. O. B. Gilbert, a student in the Agricultural Department of the University, made it the subject of his senior thesis investigation. Mr. Gilbert's home is in Dorset so that he has had the best of opportunities for the study. He made a tour through the other infested regions in Vermont, Massachusetts and Connecticut and corresponded with various botanists in this country and abroad. He also took charge of the experiments with the Angora goats. The data accumulated by Mr. Gilbert has been used freely in this account and we hereby acknowledge our indebtedness to him and to his father, Mr. F. F. Gilbert. We are also under obligations to a large number of botanical correspondents in Vermont, and other states, in Canada and in Europe for answers to inquiries addressed to them by Mr. Gilbert and the writers, among whom we would especially mention Messrs, H. M. Thomson, Mass. Agl. Coll.; T. D. A. Cockerell, New Mexico Normal Univ.; T. S. Gold, Cornwall, Conn.; A. W. Lund, Vesteroik, Sweden; W. T. Thisleton Dyer, Royal Gardens, Kew, England.

completed for some time, but it seems inexpedient to delay publication awaiting their outcome.

II. NAMES AND DESCRIPTION

The plant passes under a variety of local popular names. *Shrubby cinquefoil* is the common name used by botanical writers, but it is rarely heard among practical farmers. This is, however, the best name available for general use.

Prairie-weed or *prairie-bush* is the name in most common use in Manchester and Dorset. Tradition has it that years ago a man, bringing a flock of sheep from the western prairies, turned them into a clean pasture, and, inasmuch as this weed appeared in the pasture soon after, it was inferred that the sheep brought the seed from the prairies.

The name *sage-bush* and *wild sage*, often heard in the infested areas in Vermont, may have had a similar origin, from the supposed relationship of this plant to the western sage brush. More probably these names were given it because of the gray-green, somewhat sage-like color.

Hawley-weed, also in local use in Manchester, takes its origin from the fact that the first pasture to become overgrown in one section was that of Major Jay Hawley, a large land owner of the middle of the last century.

Manchester-weed is a common name with people of the less infested towns bordering Manchester, though naturally its use receives little encouragement from the residents of this latter place.

Sandgate-weed is a local name said to be applied to it in the town of Sandgate.

Hardhack is the name usually given to *Spiraea tomentosa*, but the similar habit of this cinquefoil has led many farmers to apply it to the latter also. This is especially true in the infested regions of south-western Massachusetts according to Thomson.[1]

Goshen hardhack or *Goshen-weed* is the common name in the vicinity of Goshen, Conn., where it is abundant.

Black brush is the name used by the ranchmen of Colorado, according to Cockerell.[2]

Chester-flower is the name given to the cultivated form in Loudon's Encyclopedia of Plants of Britain.

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[1] Thomson, H. M., Mass. Agl. Coll., Amherst, in correspondence.

[2] Cockerell, T. D. A., Normal University, Las Vegas, New Mexico, in correspondence.

GENERAL DESCRIPTION

The shrubby cinquefoil is a shrub from one to five feet high. In the young plant a few stalks branch out from the common base, but the number of these increases with age until there may be a score of them radiating to form a rounded bush, the lower nearly prostrate and, often, covering an area of twenty square feet or more. The bark, especially on the older stems, is shreddy. Five to seven leaflets are borne on each compound leaf. These have a grayish tint from a covering of silky hairs. From May until October the outer branches are dotted with pretty bright yellow flowers, about the size and general appearance of buttercups. These characters combine to make so pleasing a shrub that it is frequently used in ornamental plantings. The recent Cyclopedia of American Horticulture speaks of it as "a useful shrub, flowering throughout the year."

FIG. 4.

It is a matter of some practical as well as botanical interest to note that the plants obtained from nurseries which are in cultivation in shrubberies in Burlington, so far as observed, are sterile, the pistils or stamens being abortive. Hooker[1] states that in Teesdale, England, the flowers appear to be functionally unisexual, and "the sexes differ in appearance." Professor W. Thistleton Dyer in a recent letter to us, says that "this is true of other individuals of the same species collected in other countries and now contained in the Kew Herbarium." Observations on the plants of Newfane, Smuggler's Notch, and Lake Willoughby by Clifton D. Howe, when botanical assistant in 1901, showed all to have

FIG. 5.

Fig. 4. Sprig of shrubby cinquefoil showing leaf, flower and fruit, two-thirds natural size. (From nature by Miss E. K. Herrick.)

Fig. 5. Flower from a sterile (staminate) plant of the cultivated strain, doubtless of European origin, slightly reduced.

[1] Hooker, J. D., Student's Flora of the British Islands.

perfect flowers. He later examined those of plants on the Newfoundland coast and found them perfect. Observations in Dorset made by O. B. Gilbert showed all to be alike and perfect. The plants in culture at Burlington were probably imported stock. This suggests physiological differences which may determine in part the capacity of the plant to develop as a weed.

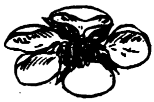

FIG. 6.

BOTANICAL NAMES AND RELATIONSHIP

The shrubby cinquefoil is a member of the Rose family, closely related to the common herbaceous weeds "five-fingers" and "silver-weed" of grass lands, and to numerous shrubby pasture weeds including the common hardhack or steeple-top (*Spiraea tomentosa*) and the brambles (*Rubus, sp.*).

The botanical name in general use is *Potentilla fruticosa*, Linn. Recently Rydberg[1] has placed it in a new genus as *Dasiphora fruticosa*. (L.) Ryd. Several varieties have been suggested from time to time, indicating a variability characteristic of members of the Rose family. Comparisons of our Vermont plants from Willoughby, Smuggler's Notch, Burlington and Manchester fail to convince us of any constant differences in morphology or habit. These plants do differ somewhat, however, from the plants used for ornament about Burlington and which, as stated above, are probably of European origin. Our native plants have more numerous flowers with shorter pedicels, leaflets more pubescent, and tending to be narrower with more revolute margins. Pursh[2] in calling attention to similar variations, as well as to difference in size when he proposed his new species *P. floribunda*, nearly a century ago, suggested that plants from various sources be planted side by side to see in how far these morphological differences would prove constant under the same environment.

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[1] Rydberg, P. A., Britton's Flora of N. States and Can. pp. 491, 499(1901).

[2] Pursh, Frederick, Flora N. Am. I. p. 356 (1814).

Fig. 6. Flower from a fertile (pistillate) plant, also probably of European origin, slightly reduced.

PROPAGATION AS A WEED

The plant forms a great abundance of seeds, a score or more per flower,[1] each slightly smaller than timothy seed, enclosed in a hairy envelope (an achene) which aids in its dissemination. These remain on the plant until winter. Most of them shed between December and March and are scattered by the wind, especially when there is a crust of snow upon which to drift. There is no reason to believe that they are ever carried by stock either in the hair or wool or through the manure.

FIG. 7.

The plant sprouts freely from the crown if cut back, but it does not spread by underground stems or roots, that is to say, it is not stoloniferous.

III. OCCURRENCE

HABITAT AND GEOGRAPHICAL DISTRIBUTION

Habitat.—The shrubby cinquefoil is at its best in cold, moist, rocky soil, preferably, according to evidence to be cited later, of limestone formation. It is not, however, closely confined to such a habitat as is shown by its remarkable development as a weed.

Geographical distribution.—Botanists find the species in the northern part of the north temperate zone throughout both hemispheres. It reaches into the Arctic circle in places, and extends well southward in the Himalaya mountains, and to the southern limits of the United States in the Rocky mountains. It is, however, essentially a plant of the cooler soils or higher altitudes. Although so widely distributed it has shown no weedy tendency outside of certain sections of New England and New York, with the possible exceptions of portions of Ohio, Indiana and Colorado.

OCCURRENCE AND DEVELOPMENT AS A WEED

The only serious developments are in New England. We will, however, for convenience, briefly state what is known of it in other sections.

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[1] A count of the achenes in a number of heads showed numbers varying from 5 to 48 with an average of 29.

Fig. 7. The hairy seed (achene) of the shrubby cinquefoil, much enlarged.

IN THE FAR WEST

Professor T. D. A. Cockerell states in a recent letter that "the shrubby cinquefoil is extremely common in the mountains of Colorado, in the Canadian and Hudsonian zones, wherever the ground is open in the immediate vicinity of the forests. That is to say it occupies the open ground skirting the wooded areas. In Wet Mountain valley, Colorado (altitude 9,000 feet), where I used to live, it is called 'black brush' and is quite troublesome to ranchmen."

Correspondence with the botanists of the Experiment stations of the Rocky mountain area failed to elicit further evidence of its weediness, although all familiar with that flora reported its occurrence. It seems fair to conclude that it is not generally troublesome in the regions where it occurs in the western states.

IN OHIO AND INDIANA

The shrubby cinquefoil has been reported[1] as showing weedy tendencies in moist soil in the vicinity of Castalia, Erie Co., where the overflow from the Castalia spring has left an abundant calcareous deposit.

It is common in the northern counties of Indiana in rich alluvial soil and "very troublesome in low fields in many places."[2]

IN VERMONT AT MANCHESTER AND DORSET

The conditions in these two towns will be described in some detail and this may serve as a basis for the discussion of other sections.

The worst occurrence of the plant is in the valley extending from two miles south of Manchester to Dorset village, a distance of about ten miles. It is no exaggeration to say that with rare exceptions every hillside pasture in Manchester is filled with this pest and the same is true of those of all of Dorset except in the north-west portion. A conservative estimate gives 5,000 acres as the area almost wholly occupied by this plant. This is a narrow valley of high elevation, about 1,000 feet, at the head waters of the Otter Creek and Pawlet rivers which turn north towards Lake Champlain and of the Battenkill river, the

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[1] Selby, A. D., Ohio Sta., in correspondence.

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[2] Coulter, Catalog of the Flowering Plants and Ferns and Allies Indigenous to Indiana. In Report of State Geologist of Ind., 19, p. 785.

course of which is southward to the Hudson. The soil is naturally rich. The hillside pastures, where most of the cinquefoil occurs, are rocky and moist, having in most places a gravelly subsoil. It is a limestone region with several marble quarries. The plant usually gains its first foothold in the moister situations, but it is by no means restricted to these. The tallest plants and most crowded growth occur in rich soil of a medium degree of moisture, and even the dryer summits of the rounded knolls are completely covered with its growth. It rapidly encroaches upon any field which is left unplowed for a few years, unless kept out by the closest pasturing and digging. The rapidity and completeness of its invasion may be illustrated by a specific case of a pasture of some thirty acres. Thirty years ago this was a clean pasture of the very best quality. Twenty years ago it was, generally speaking, free from this weed, but since that time the cinquefoil has rapidly increased, until to-day the field is scarcely worth fencing for pasture purposes. It is covered with an almost impenetrable matted growth from two to four feet in height, through which the cattle make their way only along narrow paths. The grass, even where the animals can reach it, is scant and spindling. (See Plate I.)

Without doubt the plant was a native of this section. Most of these fields were first cleared of forest and brought under cultivation a hundred years or more ago. During the first half of this period there seems to have been little trouble with the cinquefoil. Traditions date its first encroachments back some fifty years, and its serious development, at least in most sections, has occurred within thirty or forty years. The testimony is conclusive that it is extending its invasion into new territory in certain directions.

ELSEWHERE IN VERMONT

West and south of Manchester it is found in the adjoining towns of Sandgate and Arlington, though it is less troublesome here. Little of it occurs south of this point in Vermont until Pownal, the southern border town, is reached, when the back pastures are full of it.

North of Dorset there is little of it in the Pawlet valley, but it follows the course of the Otter Creek from the east side of the town northward through the towns of Danby, Tinmouth, Clarendon, Rutland and Pittsford, then it retreats to the hillsides on the east side of the valley where scattered areas occur in Brandon and Salisbury. The latter place, forty miles north of Manchester, marks its northern extension as a weed, and, indeed, so far as is known to us, no cultivated plants have been found, even by botanists, north of Salisbury, except in the Winooski gorge near Burlington, Smuggler's Notch of Mount Mansfield and the Lake Willoughby cliffs.

It is frequent in certain localities east of Manchester and Dorset in the valleys tributary to the Connecticut, and has been making somewhat alarming headway in recent years in sections of Stratton, Jamaica, Windham, Wardsboro, Newfane, and other portions of the West River valley.

Specimens have been brought to us from Strafford, fifty miles further north in the Connecticut valley, but no complaints have been made of it as a weed.

IN MASSACHUSETTS

In western Massachusetts, especially in the south-western portion, the development of the cinquefoil as a weed is similar to that of Manchester and Dorset. O. B. Gilbert, as a result of his observations, says: "in Berkshire county, Massachusetts, it is common in nearly if not quite every town; but that is not saying that it is common in every pasture by any means."

H. M. Thomson, late of the Massachusetts Agricultural College, who first informed us of its extensive occurrence in western Massachusetts, wrote us as follows in 1899: "It is abundant in the south-western part of the State. I am acquainted with it in my old home, Monterey, and in all the surrounding towns. I know it to be in Great Barrington. On the east there is a line passing through Blandford and Becket beyond which it does not go. I know of it in Pittsfield and Dalton on the north and it extends into Connecticut on the south. In the towns of Monterey, New Marlboro, Otis and Sandisfield nearly all the pastures and waste lands are covered with hardhack[1] to a greater or less extent."

IN NEW YORK

C. H. Peck, New York State botanist, writes us that he has seen it occupying moist pastures in Columbia county, which adjoins Massachusetts on the east.

IN CONNECTICUT

In Litchfield county, in north-western Connecticut, it occurs much as it does in western Massachusetts. Hon. T. S. Gold, Ex-Secretary of the State Board of Agriculture, who lives in this country and knows the weed, writes that "this region was settled about 1750. The hardhack[1] lands of to-day were then the best pastures and it is within the memory of our old men that it first became a troublesome pest. It spreads rapidly and now thousands of acres in this country are infested with it."

J. H. Putnam of Litchfield, adds further testimony along the same line. "Fifty years ago Goshen was the most noted cheese section in the country, but what were the finest dairy lands are now great areas of hardhack.[1] It takes many acres to keep a cow, and it hard to see where they get anything at all. Once valuable land is worthless because of this pest." Its prevalence here has led to its Connecticut name, "Goshen hardhack."

RELATION OF ITS WEEDY DEVELOPMENT TO SOIL CONDITIONS

The native habitat of the shrubby cinquefoil is always cool, moist and usually rocky situations. Its original stations in the areas under consideration were doubtless the borders of swamps and streams and in springy places. In its present occurrence as a weed it shows a decided preference for such situations, but it is by no means confined to them. Once established its abundant crop of seeds is annually broadcasted over all adjacent fields and the plants spring up everywhere from the summit of the gravelly knoll to the rich cultivated lowland.

The remarkable development of the plant as a weed in the clearly defined area under consideration suggests some favoring conditions other than soil moisture. The infested area in New England and New York, as described, extends in a narrow belt from Salisbury, Vt., at the north, with a slight interruption in south-western Vermont, through western Massachusetts, a little of adjacent New York and well into north-western Connecticut. All along this area it has sharp delimitations on both the western and the eastern borders. This region is outlined in the accompanying sketch.

It is a noteworthy fact that the badly infested areas are without exception calcareous soils, and, in most cases, they are in the limestone belt. This relation will become clearer by comparing the distribution of the weed with the limestone formation of western New England, as shown in the accompanying map, figure eight.

As bearing upon the apparent relation of calcareous soils to the weed, attention is called to the fact that the only area in Ohio known to be invaded with the shrubby cinquefoil as a weed is, as already stated, a soil strongly impregnated with lime as a result of its being flooded with the overflow from the famous Castalia springs.

We do not wish to imply that this plant is confined to calcareous soils. It does seem to us probable, however, that its rapid development as a weed is to be expected in such soils, and it is to be hoped that in soils of other character it may give little if any trouble. If this is the case it may be expected gradually to extend its area of invasion in the

[2] Shrubby cinquefoil. See page 174.

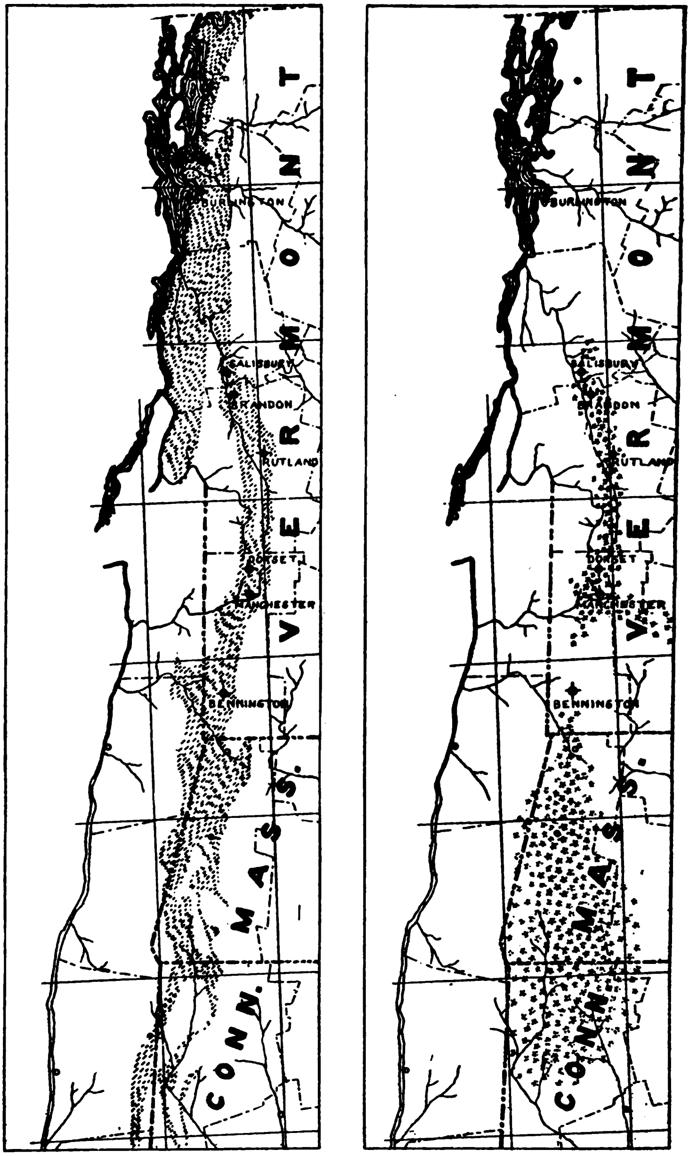

FIG. 8. The above maps show the striking relation between the distribution of the shrubby cinquefoil as a weed in Vermont and the adjacent States, as indicated by the starred areas on the map at the right, and the calcareous rock formations indicated by the shaded areas on the map at the left.

Champlain valley in Vermont and to prove relatively less troublesome in the Connecticut valley.

IV. POSSIBLE ECONOMIC VALUE

It has been suggested that this plant has economic value. If so, it would be a happy thing to know of it.

Hon. T. S. Gold states that there was formerly some local manufacture in Connecticut of stable and street brooms from the branches of this cinquefoil. He suggested in correspondence that, although this industry has now ceased it might be revived profitably in case of scarcity or high price of broom corn. Retrius[1] states that a similar use of it is made by the inhabitants of the Swedish island Oeland.

A Manchester farmer has suggested the possibility that the plant may be used as a source of tannin, but we can find no evidence either in practice or in botanical literature that it has value for this purpose. An examination made in the chemical laboratory of the Station shows but traces of tannins.

The plant, therefore, has no use other than its doubtful ornamental value. The fact has already been mentioned that it is frequently used as are the related spiraeas for ornamental planting both in Europe and America. The plants handled by American nurserymen are, we believe, of European origin and their sterility (see page 176) commends them, since they will not form possible centers of infection. A remark by Mr. Gold on this point is pertinent. He says the United States Department of Agriculture in some of its earlier reports advised the use of this plant as an ornamental which was "very hardy." Mr. Gold adds that "if one of these advisers were to get into one of our hardhack lots with full grown, *hardy*, plants looking smooth and nice and as high as his head, when he were out for a ramble on a muggy day, he would rejoice when he reached a fence or some other sign of civilization."

V. METHODS OF CONTROL OR ERADICATION

Prevention

The rule that "An ounce of prevention is worth a pound of cure" is as good in fighting weeds as it is in fighting diseases. This is not a weed likely to be introduced with grass or grain seed or with manure. Its seeds are not carried long distances by the wind, at least not in great numbers. As already stated its invasion is probably wholly through seeds drifting on the snow crust in winter, and these in Ver-

[1] Retrius, A. J., Flora Oeconomica Sueciæ as quoted in correspondence by A. W. Lund of Vesteroik, Sweden.

mont fields cannot go long distances. If fields are free from it, it is not difficult to keep them free, unless they are in immediate proximity to infested lands. Even then it can be done as is amply shown by certain fields in Manchester. Some farms are practically free from the plant although adjacent and similar fields are overgrown. Their occupants control it in part by cutting out occasional plants, but chiefly by *heavily stocking their pastures* with cattle, so that everything is kept closely fed to the ground. High grade, intensive, dairy farming will, in our judgment, keep clean the fields not as yet occupied by it. One dairyman who has had long experience with it, recently said "if I had to fight hardhack over again I should do it with bran." When the pasture is too large to admit of stocking the whole of it heavily enough to keep down the weeds, it will probably prove better in the end to fence off the back portions and let them grow up to trees at once, while heavily stocking the balance and giving it sufficient care to keep it free from this and other weeds.

These statements apply to land already free or nearly free from shrubby cinquefoil. It is not so easy to say what course is best with the fields completely occupied by it. The following discussion summarizes our present judgment regarding this matter.

BURNING

If a fire is started in a thick field of the cinquefoil in early spring, just after the snow goes off, the tops burn readily and most of them are destroyed. An abundant crop of young sprouts comes up from the base of each stem, however, and since the burned-off stubs are unpleasantly sharp and prick the nose of cattle, the stock allow these to grow and, hereby, but little is gained. It is said that burning two years in succession improves conditions. This method, however, seems to have found but little favor with farmers in the infested regions. At best it is only temporizing with the evil. Possibly the combination of burning with the use of goats, or with reforestation, as discussed later, may prove desirable upon further trial.

MOWING

What has been said of burning will in general apply to mowing. Ordinary farm stock will not crop the second growth close enough to keep it down, so this again only gives the plants a temporary setback. Mowing may be a good practice where the plant is just coming into the pasture. Occasional mowing will not kill the plant, however, as may be seen in numerous wet meadows where the plants are mown annually with the hay.

PLATE I. A view of pasture lands overgrown by the shrubby cinquefoil, Dorset, Vt. This land was the best of pasture twenty-five years ago. It is not "exhausted" or "worn out," yet is now practically valueless for pasture purposes because of the dense shrubby growth of this plant.

PLATE II. Two Angora goats inclosed in a half-acre of the weed infested pasture of Mr. F. F. Gilbert, Dorset. They have stripped the leaves completely from every shrub in the enclosure. Compare the dark naked branches here shown with the abundant foliage shown in Plates I and III, photographed on the same day. (See page 86)

PLATE III. This shows the peculiar antagonism between the butternut and the shrubby cinquefoil. The ground is fully occupied by the latter except for the circle surrounding the young butternut tree at the right center of the field. Not a living plant of cinquefoil occurred within the circle shown as a dark ring. At the left are trees of two or three other kinds none of which show such antagonism. (See page 188)

PLATE IV

Fig. 1. A nine-year old apple tree completely girdled by the round head borer. (See page 205.)

Fig. 2. A two-year old borer removed from his tunnel. (p. 205)

Fig. 3. A portion of the trunk of an apple tree showing two tunnels from which the mature insects have emerged at a and b. (p. 205)

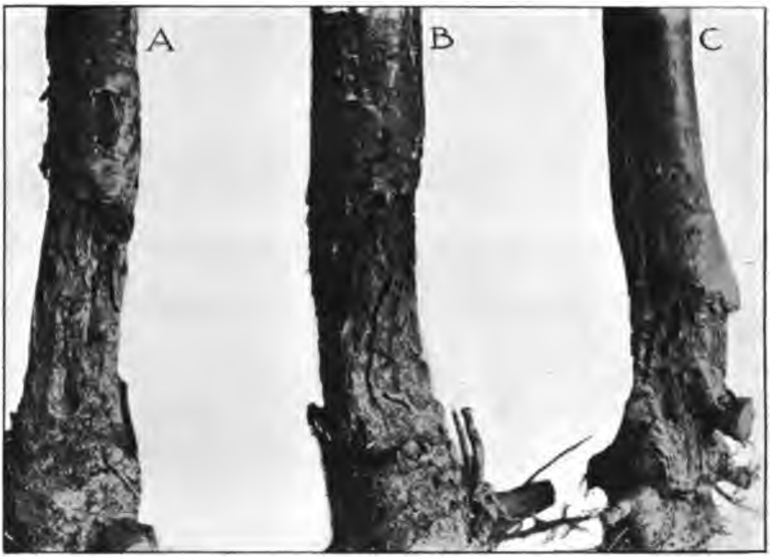

PLATE V

Trunks of three apple trees ruined by borers. The circular holes in the upper portion of trunks B & C were made by the mature insects when they emerged from the tree. **(See page 205)**

From the middle of July to the first of September is probably the best time for mowing this as is the case with most shrubby growths. The plants may be cut off with a grub hoe just beneath the surface, thus leaving fewer stubs. A method recommended as accomplishing the same end in a more satisfactory manner is that of knocking the plants out with an axe or grub hoe when the ground is frozen.

PLOWING, GRUBBING AND PULLING

Plowing with grubbing and pulling out the larger stools is the only method fully endorsed by most practical farmers in the infested regions. The general method is to go into the field with a strong team, heavy plow and two or three men. All except the largest plants can be turned out with the plow. The largest must be grubbed out or pulled with horse and chain. After picking up the plants that are thoroughly loosened the piece is gone over with a spring tooth harrow to loosen up and drag out the rest. The plants are piled and in forty-eight hours, if the weather is dry, all except the largest roots will burn. Three men with a strong team will clear up from one-fourth to three-fourths of an acre a day. To hire this crew will cost about $6.00, making the cost from $8.00 to $24.00 an acre. This, unfortunately, is more than most of the land is worth after it is cleared. Frequently such work can be done at leisure times with the regular farm help, under such circumstances the cash outlay is really less than appears in this estimate.

A common practice is to sow buckwheat the first year, potatoes or winter rye the year following, and then to seed down with grass. It is the testimony of those who have so cleared up cinquefoil fields that the land occupied by it is in excellent condition when reclaimed, apparently having been improved rather than exhausted by its occupancy.

THE USE OF STOCK

CATTLE AND SHEEP

Cattle and sheep will browse the cinquefoil somewhat, but they refuse to make it a steady diet. Hon. T. S. Gold writes that "it can be discouraged with close pasturing and some grain feeding. . . . . Twenty years ago I had a four acre pasture lot too rocky to plow or mow, covered with hardhack. I put my summer milking yard in a corner and sixty cows cropped it or lay on it for the night. The result is the hardhack has disappeared almost entirely." H. M. Thomson says, "Cattle and sheep eat the tender shoots. . . By burning it two

springs in succession and then stocking heavily with sheep or cattle the plant will be kept down for a time."

In short, the general testimony is that heavy stocking of the threatened pastures *which are free from* the weed, supplementing the pasture with grain as needed, will keep the weed out, but that it is practically impossible to kill out a fully established growth of it in this way.

ANGORA GOATS

This animal has been widely heralded during recent years as an aid in killing brush in pastures. It has, therefore, seemed worth while to make trial of it in connection with this particular problem. Two young ewe goats were sent in May, 1902, to Mr. F. F. Gilbert, Dorset, for trial. He inclosed them in an area of one hundred square rods in a corner of his pasture which was completely overgrown by this plant. They have been kept there now during two open seasons. A small stream crosses one corner of the area and furnishes the animals with water. They have been given salt occasionally, but, aside from that, have had nothing from outside of the enclosure. Practically all the choice the goats have had as to food is that between cinquefoil, grass and the hay-scented fern.[1] They have shown a preference for the cinquefoil as between these. In order to keep the grass and ferns and herbaceous weeds cropped back, two sheep were placed in the inclosure during midsummer of each 1902 and 1903. These sheep do not touch the cinquefoil. The outcome to date is promising, but not enough time has elapsed to make it decisive.

The summer of 1902 was a wet one, hence unfavorable for the goats and favorable for the plants. Nevertheless the goats soon stripped most of the foliage from the cinquefoil, and they have continued since to browse the young growth back about as fast as it has appeared. (See Plate II, opposite page 185.)

In July, 1903, when the last observations were made, many of the branches of the cinquefoil were dead, but a majority were continuing to send out struggling young shoots. Most of the stools were sending up some shoots from the base also. Since the goats were cropping these off promptly it seems probable that few plants in this area will survive the winter of 1903-04. Whether the goats fully exterminate the weed or not they certainly will come near to doing so. By keeping the foliage browsed from the bushes the sunlight is admitted so that the value of the grass in the area is already doubled or trebled.

We are not as yet posted as to whether Angora goats will or will not prove satisfactory or profitable as farm stock in New England. Most

[1] Dicksonia pilosiuscula.

writers in the agricultural press claim that they will; but it is to be remembered that such press reports are apt to originate with goat dealers and fancy breeders rather than disinterested farmers. There are certainly some disadvantages and drawbacks in the way of liability to disease, difficulty in rearing the young, and expense of fencing which are not commonly presented.

These goats have been inclosed with a forty-two inch woven wire fence set close to the ground, and have never jumped out. They have shown no tendency to disease. They were allowed to run with a buck goat during part of December and January, but did not breed.

In conclusion, the hope is expressed that the Angora goat may prove a valuable aid in subduing if not wholly exterminating this plant, together with hardhack or steeple top[1] and similar shrubby growths in Vermont pastures.

REFORESTATION

General remarks.—There can be no doubt that considerable areas of so-called pasture lands in Vermont and the other New England states are destined to revert to tree growth in the near future. The increasing value of wood for lumber and pulp, and the scarcity and high price of farm labor, combine with various other causes to insure this outcome. It is beyond doubt that the sooner tree growth begins upon certain classes of land the better it will be for the next generation and for the State as a whole.

In so far as pasture weeds like the orange hawkweed, brake, hardhack and shrubby cinquefoil force upon the doubting landowner the wise decision to fence off such portions of the back pastures as are practically worthless for stock grazing and permit trees to take possession, they may indeed be blessings in disguise. This will seem to many a harsh and heartless doctrine. If understood aright, it is not so. Nature is kindly, if her laws are heeded; but those laws are changeless, and he who opposes them must suffer and meet sure defeat. A more liberal fertilization and a heavier stocking of the lower and better pastures, combined with gradual relinquishment to forest growth of the poorer and less accessible ones, is the inevitable course before Vermont farmers.

Fortunately the shrubby cinquefoil is killed quickly by tree growth of any kind. If stock is fenced out of a field trees will soon come in, and the cinquefoil weaken and die out as the trees overshadow it. It will probably be more profitable thus to encourage tree growth in many infested fields than to try to reclaim them by plowing or stocking. If

[1] Spiræa tomentosa.

this is to be done it may be profitable to plant certain kinds of trees to occupy at least a portion of the ground rather than to leave the development entirely to nature.

WHITE PINE

We are convinced that where white pine grows well plantings of this tree will prove profitable. Land that is to be planted should be burned over as early as possible in the spring. White pine seedlings from the nursery should be set in April or early May, as soon as the buds start. These may be bought as a rule cheaper than they can be grown, viz., $5.00 per thousand, more or less, depending upon the number ordered. It will take 1,200 trees to the acre. If the planting is done with a mattock it is said that two men experienced in planting will set the trees on three-fourths of an acre daily. Judging from the results where a few young pines are growing in an infested field in Dorset, the cinquefoil will not yield to them as quickly as to some other kinds of trees.

YELLOW LOCUST

Locust trees may be grown with profit for posts and deserve trial planting in infested areas.[1] They make a very rapid growth, are easily started from seed and transplanted, and when cut reproduce themselves from the root. We know nothing as to how quickly they would overcome the cinquefoil.

WILLOWS

Concerning tree-planting in relation to the cinquefoil, Mr. Gold writes as follows: "In one field I planted one half acre with gray willow scions from Illinois, thirty years ago. They grew well and checked the hardhack. In about fifteen years I cut a good crop of firewood, and now there is another crop. Willows are better than nothing."

BUTTERNUTS

A remarkable thing observed in connection with shrubby cinquefoil is the apparent antagonism existing between it and the butternut tree. This is a matter of common report with the farmers of Manchester and Dorset and careful observations by the writers have confirmed their idea. The cinquefoil rarely grows close to a butternut tree. This fact is strikingly shown where butternut trees occur in fields overgrown with the cinquefoil. Each large tree occupies the center of a clear grassy circle of a diameter considerably exceeding

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[1] See Vt. Sta. Rpt. 15 pp. 239-243 (1902), for statements as to locust growing.

the farthest spread of its branches. The deadily influence of the butternut is made even more evident in the case of rapidly growing young trees by the fact that the base of the tree forms the center of an area of dead cinquefoil plants. (See Plate III, opposite page 185.)

Moreover with such butternuts the "dead line" for the weed is pushed outward year by year as the tree enlarges so that the trees may be surrounded by a circle of dead and dying cinquefoil plants bordering the clean grassy plot under the tree. This antagonism is, we believe, attributable rather to the root relations of the two plants than to those of shade. Thus young butternuts from two to eight feet high were observed to be surrounded by a circle which might be twice the diameter of the top of the tree within which the weeds were dead and with dying plants bordering its margins. Such butternuts do not cast much shade. Moreover, young birch, beech, maple, cherry, apple, and pine trees in the same field showed no such striking relation to the death of the cinquefoil, healthy plants of the weed frequently crowding close under their branches.

In order to secure further data as to the root relations of these two antagonistic plants, one of our student assistants, A. H. Gilbert, was commissioned to dig up the dead and dying cinquefoil in the vicinity of some butternuts at Dorset. He recently did so and, while he wishes to make further observations another summer before considering the evidence fully satisfactory, he was led to conclude that the butternut roots are in some way attracted to the area occupied by the cinquefoil roots. In every case examined, the dead or dying cinquefoil clusters within the affected circles had butternut roots of considerable size passing directly underneath or close alongside the base. In several cases two or more butternut roots, growing from different directions, intersected directly in the root clusters of the cinquefoil; and there were no other butternut roots within some distance of these plants. One butternut root twelve feet long and about one-half inch in median diameter was followed from the tree to its terminus, and it was found to pass immediately under two successive clusters of the weed and to be growing directly toward a third. The bunch nearest the tree, and which was reached first by the root, had evidently been dead some years, since the top was rotten and the stems easily pulled from the root. The second was dead, but sound, showing a more recent death. The third was still living.

Another observation by Mr. Gilbert, showing that the fatal influence of the butternut is from root rather than foliage relations, was as follows: Near a large mature butternut tree and well within the circle where the weeds had elsewhere been killed, several green healthy

cinquefoil plants were observed in striking contrast to the rest of the circle. Upon investigation it was found that these were growing in very thin soil, overlying a ledge which so rose as to form a barrier over which no butternut roots had passed in this direction. In another case the cinquefoil plants were all killed except in a wet spot. The soil was not dug up, but we are now inclined to believe that the immunity of these weed plants was because there was so much water as to prevent the growth there of the butternut roots. No evidence of root parasitism was detected in any case, although sought for. The suggestion is rather that the invasion of the soil by the more vigorously growing butternut roots which develop near the surface may interfere with the nutrition of the cinquefoil in some way. The matter is certainly deserving of further investigation.

From the practical standpoint it is evident that the butternut should be given a prominent place in any scheme of reforestation looking to the extermination of the cinquefoil. One young butternut on each square rod of infested soil would probably in ten years' time kill most, if not all, of the cinquefoil.

REPORT OF THE CHEMIST

C. H. JONES

The work of the chemist for the past year includes the analyses of commercial fertilizers collected in 1903 and published in bulletins 98 and 99; analyses of commercial feeding stuffs, bulletins 97 and 101; and the analytical work incident to the feeding experiments reported later in this volume under the head of "Dairy Feeding," including the analyses of coarse and fine feeds as well as of milk and butter.

Some work on nitrogen availability was done for the Association of Official Agricultural Chemists.

A study of the chemistry of the flow of maple sap has received attention for several seasons, the results appearing in bulletins 103 and 105.

There have also been examined 145 samples of miscellaneous materials, sent in by residents of the State, exclusive of over a thousand milk samples.

The matter deemed worthy of permanent record is presented under the following heads:

Cream testing.

Composition of edible mushrooms.

Analyses of infant foods.

On the quantitative separation of malose and lactose, by C. I. Boyden.

Miscellaneous analyses.

CREAM TESTING

Considerable attention was given during the past summer to the subject of cream testing with a view of determining the reliability of the Babcock test with creams of varying richness when 18 cubic centimeters of cream was used instead of the required 18 grams. Correct results are attained only when 18 grams of milk or cream are actually delivered into and contained in the bottle. It is well know that 18 cubic centimeters of cream testing over 20 percent fat, when pipetted into a cream bottle will not weigh 18 grams by reason of the specific

gravity of the fat, adherence to the sides of the pipette, temperature, air bubbles, etc. Consequently results are low when rich creams are examined, unless especial pains be taken to ensure that a full 18 grams, no more and certainly no less, are used. The weighing of the pipette full of cream is somewhat of a bother though not enough so to warrant serious objection. If, however, any modification of the process which would obviate this difficulty could be devised, or any adequate correction factor be formulated, it would be well worth while.

It is the custom in some creameries to heat the cream samples in a water bath to a temperature of about 140° F. This procedure increases the fluidity of the cream to a marked degree. Even very rich samples (40-50 percent fat) may be thus quickly got into suitable shape for the pipetting, which is done before the samples cool.

Where this procedure is in use a percentage correction or addition is made to the result obtained in an attempt to correct for expansion, and, also, for the amount of fat left clinging to the inside of the pipette. It was more particularly to test the adaptability of this modification of the cream testing operation that our work was instituted. The results obtained were briefly summarized in bulletin 100, pages 8 9. The detailed data from which the conclusions were drawn appear below. The samples used were obtained from a Vermont creamery and were taken by the management in the regular course of sampling. No preservative was added. They were from 24 to 36 hours old when received, sweet and in good condition.

A survey of the table shows, as might be expected, that the results obtained when 18 grams of cream are weighed into the bottles was greater in every case than when 18 c. c. of the cream at 140° F. was used. This difference varies from 0.25 to 7.75 percent; the former in the case of a 25 percent cream and the latter in that of a cream carrying 53 percent of fat.

It will be seen, moreover, that sundry creams of practically similar fat contents vary to quite an extent as regards the amount delivered by the pipette under these conditions. This indicates, that, in spite of uniform conditions of preparation, each separate cream may be a law unto itself as to its freedom of flow from a pipette.

FAT CONTENT OF CREAM SAMPLES

No.	18 grams used %	18 cc. at 140° F. used %	*Difference* %	No.	18 grams used %	18 cc. at 140° F. used %	*Difference* %
1	28.	26.75	1.25	49	31.50	29.75	1.75
2	25.	23.50	1.50	50	32.	30.	2.
3	24.25	23.	1.25	51	31.	29.50	1.50
4	27.	26.25	0.75	52	35.50	34.	1.50
5	28.50	26.50	2.	53	37.75	35.	2.75
6	27.	26.25	0.75	54	30.50	28.50	2.
7	29.75	28.25	1.50	55	36.25	34.25	2.
8	27.25	26.25	1.	56	32.	29.75	2.25
9	25.25	25.	0.25	57	39.	36.50	2.50
10	29.	27.90	1.10	58	30.	28.	2.
11	27.	25.25	1.75	56	37.50	34.	3.50
12	28.50	27.	1.50	60	33.50	32.50	1.
13	36.	34.50	1.50	61	31.	29.50	1.50
14	31.50	30.50	1.	62	35.50	34.	1.50
15	30.75	29.	1.75	63	36.50	33.50	3.
16	38.	35.50	2.50	64	31.	30.50	0.50
17	36.75	34.75	2.	65	38.	35.50	2.50
18	34.25	33.	1.25	66	33.	3.250	0.50
19	33.	31.25	1.75	67	32.50	29.75	2.75
20	32.	29.50	2.50	68	34.	31.50	2.50
21	33.	30.50	2.50	69	34.50	33.	1.50
22	32.	30.75	1.25	70	43.75	41.50	2.25
23	30.	28.	2.	71	40.50	38.	2.50
24	30.75	28.25	2.50	72	41.50	37.50	4.
25	30.75	30.	0.75	73	42.	38.25	3.75
26	34.25	33.	1.25	74	44.25	40.	4.25
27	35.50	33.25	2.25	75	43.	40.	3.
28	34.75	32.	2.75	76	41.	39.	2.
29	33.50	31.	2.50	77	47.	42.50	4.50
30	35.	32.50	2.50	78	47.	42.	5.
31	32.	30.	2.	79	47.25	41.	6.25
32	35.	33.	2.	80	40.	37.25	2.75
33	32.75	31.25	1.50	81	42.25	38.50	3.75
34	35.50	33.	2.50	82	41.50	37.50	4.
35	36.	34.25	1.75	83	49.	44.	5.
36	38.	35.	3.	84	41.50	37.50	4.
37	33.50	32.	1.50	85	40.75	38.50	2.25
38	39.	37.	2.	86	43.	39.	4.
39	30.50	28.75	1.75	87	42.75	40.	2.75
40	32.25	30.75	1.50	88	42.25	38.50	3.75
41	36.50	34.50	2.	89	43.25	40.	3.25
42	30.75	29.50	1.25	90	42.50	39.50	3.
43	37.50	35.	2.50	91	45.	39.	6.
44	35.60	33.25	2.35	92	44.25	39.	5.25
45	35.75	32.	3.75	93	50.	44.60	5.40
46	30.	28.50	1.50	94	51.	47.	4.
47	30.25	29.	1.25	95	53.	45.25	7.75
48	32.50	31.50	1.				

The following summary shows the minimum, maximum and average differences in fat percentages between the tests by weight and those obtained by the employment of the modified method.

Cream testing	Percent of fat				
	24.25—29.9	30—34.9	35—39.9	40—44.9	45—53
Number of samples.....	12	33	23	18	9
Minimum difference %..	0.25	0.50	1.50	2.00	4.00
Maximum difference "..	2.00	2.75	3.75	4.25	7.75
Average difference "..	1.20	1.60	2.40	3.20	5.40

The weights of the 18 c. c. pipette delivery were taken in several cases on creams of varying densities and the results appear below:

Number	Percent fat, 18 grams cream used	Percent fat, 18 c.c. cream at 140° F. used	Weight of heated cream delivered by 18 c.c. pipette expressed as grams	Number	Percent fat, 18 grams cream used	Percent fat, 18 c.c. cream at 140° F. used	Weight of heated cream delivered by 18 c.c. pipette expressed as grams
9	25.25	25.	17.5145	64	31.	30.50	17.1259
12	28.50	27.	17.1024	65	38.	35.50	16.9500
38	39.	37.	17.0075	66	33.	32.50	17.1945
44	35.60	33.25	17.2535	86	43.	39.	16.9662
51	31.	29.50	17.2440	87	42.75	40.	16.8846
52	35.50	34.	17.0060	88	42.25	38.50	16.7965
56	32.	29.75	17.2858	89	43.25	40.	16.9116
57	39.	36.50	16.8950	90	42.50	39.50	16.7745
62	35.50	34.	17.0693	91	45.	39.	16.1305
63	36.50	33.50	13.9414	92	44.25	39.	16.3865
a	20.	19.25	17.5100	c	29.50	28.	17.0900
b	24.25	23.	17.2660	d	34.	31.	16.9460

Between creams carrying 25 and 45 percent fat the differences in the weight of 18 c. c. are quite marked. With the several creams of more nearly equal fat content the weights are oftentimes conflicting, though the differences are slight. The data accentuate the individuality in creams of which previous mention has been made.

In a few cases the cream adhering to the pipette after 18 c. c. had been run out was washed into a milk bottle and the fat determined. The results appear below:

FAT ADHERING TO THE PIPETTE

Number	Percent fat in cream. 18 grams used	Percent fat adhering to pipette	Number	Percent fat in cream. 18 grams used	Percent fat adhering to pipette
12	28.50	0.65	a	20.	0.40
57	39.	1.20	b	24.25	0.60
62	35.50	1.10	c	29.50	0.80
64	31.	0.80	d	34.	1.00
88	42.25	1.40			
92	44.25	3.			

Samples a, b, c and d were mixed in the laboratory from cream and skimmilk from the station dairy and were preserved with formalin. It is seen that as the fat content of the cream grows larger an increased amount of fat is left in the film on the pipette. This lagging fat is not constant in amount nor does it always increase in proportion to the richness of the cream. There was in one case but 0.55 percent more fat left in the pipette from a 39 percent cream than from a 28

percent lot, while in another case (samples 88 and 92) when there was a variation of only 2 percent in the fat content of two rich creams, more than twice as much fat was left behind in the pipette from the richer cream than remained when the slightly thinner one was tested. With the laboratory samples a, b, c and d, the differences grade more uniformly.

To ascertain the uniformity of delivery among different pipettes a set of five were selected. The outlet of these varied noticeably in size, that of No. 1 being the largest, No. 2 next, etc. The trials were made on a sample of fresh cream testing 39 percent fat and the results are shown in the following table:

Pipette No.	Weight of 18 c.c. delivered at 60° F. *grams*	Weight of 18 c.c. delivered at 140° F. *grams*	Weight of 18 c.c. delivered after heating to 140° F. and cooling to 60° F. *grams*	Same as previous column after interval of some hours *grams*
1	17.6190	17.1970	17.4740	17.5000
2	17.5160	17.0720	17.3190	17.6080
3	17.6300	17.1800	17.429	17.5420
	17.4785	17.1485	17.3745	17.5085
5	17.5210	17.2390	27.4770	17.5770
Average	17.55	17.154	17.42	17.55

The figures indicate that the weight delivered is quite uniform, the extreme variation being but 0.167 grams, amounting to less than 0.40 percent fat on a 40 percent cream.

Summarizing the results obtained by comparing the true fat percentages, as found by weight, with those determined by the measurement of hot cream it is seen that even with a factor correction the agreement is not as satisfactory as could be desired. Sets of correction factors which served fairly well with creams carrying less than 40 per cent fat were determined by two distinct processes. One was based on the actual tests of the cream by weight and by volume; the other on the weight of the 18 c. c. pipette delivery.

About 80 percent of the results with cream testing under 40 percent fat, when increased by the calculated correction factor showed a fair agreement with truth. This did not prove to be the case with richer creams (testing over 40 percent), for 60 percent of the number examined showed wide divergences, more largely in one direction than the other, thus indicating that the errors would not offset each other but would accumulate on one side.

Our work was done on comparatively fresh samples to which no preservative had been added. Although we have no data which would warrant dogmatic statement the writer sees no reason why results

should be any more satisfactory when working with composite or preserved samples. Indeed, it would seem as if they would, if anything, tend to be less satisfactory. There seem to be individual differences among creams which make correction factors unreliable when applied to measured volumes of rich cream. Such a correction is perhaps better than none at all, but if accurate results are desired it would seem necessary that 18 grams of cream be weighed into the test bottles.

In preparing miscellaneous cream samples for analysis it has been our custom to warm the samples in a water bath to a temperature of about 110° F. This materially increases their fluidity. The cream is then poured through a fine wire mesh sieve, that can be purchased at any notion store for five or ten cents. Any lumps or clots present remain on this sieve and, by partially submerging it in the liquid, these may be easily broken up and made to pass the mesh, by rubbing with the finger or pestle. This method is rapid and avoids all unnecessary shaking and frothing.

COMPOSITION OF MUSHROOMS

As occasion has offered during the past few years, samples of edible mushrooms found in and around Burlington have been secured, identified and analyzed.

The results appear below:

NAME	Water	Dry matter contains %									
		Crude ash	Crude protein	Crude fiber	Ether extract	Total nitrogen	Albuminoid nitrogen	Non albuminoid nitrogen	Phosphoric acid	Potash	Pentosans
	%	%	%	%	%	%	%	%	%	%	%
Agaricus arvensis (Horse mushroom)	92.67	11.26	63.75	7.55	2.14	10.20	5.73	4.47	3.34	5.72	1.50
Agaricus Rodmani (Rodman's mushroom)	91.31	14.25	42.81	10.60	2.14	6.85	4.55	2.30	2.45	5.04	1.42
Boletus subluteus (Small yellowish boletus)	91.18	9.48	23.44	13.72	5.24	3.75	2.93	0.82	1.67	3.78	2.47
Coprinus atramentarius (Quaker gray) *Tops*	95.00	23.80	36.68	7.66	5.81	5.87	3.76	2.11	4.03	7.17	2.32
" " *Stems*	93.68	32.58	20.31	14.56	1.77	3.25	2.62	0.63	2.28	7.07	1.31
Coprinus micaceous (Glistening coprinus)	92.03	19.50	30.71	4.38	1.83	4.91	4.01	0.90	3.37	7.77	[2]
" "	94.70	21.08	35.96	4.58	4.95	5.71	4.26	1.45	4.04	7.94	[2]
Coprinus squamosus (Scaly coprinus)	89.12	15.50	32.06	10.28	3.28	5.13	3.70	1.43	2.64	6.38	1.67
Lepiota Naucinoides (Smooth Lepiota)	90.24	18.96	46.19	13.45	2.87	7.39	4.08	3.31	4.34	8.15	1.14
Lycoperdon giganteum (Giant puff ball)	91.51	6.73	60.94	29.76	1.21	9.75	5.79	3.96	2.93	2.30	0.30
Morasmius oreades (Fairy ring)	89.65	10.34	48.13	11.32	4.85	7.70	3.72	3.98	4.06	3.84	1.59
" "	88.82	14.83	39.25	11.72	3.13	6.28	5.22	1.06	3.42	2.63	1.24

[1] Nitrogen × 6.25. [2] Not determined

The analyses show, as has been pointed out by other observers, that mushrooms are particularly rich in water, the amount varying from nearly 89 to 95 percent. Their chief value as food is derived from the nitrogenous matter present. Many writers have overrated their value in this particular. The greatest amount of nitrogen found among the samples examined was 10.20 percent, on a dry matter basis, which when calculated to its original moisture amounts to but 0.75 percent. Forty-four percent of this nitrogen was present in the non-albuminoid form, which does not have the food value of protein. A considerable proportion of the nitrogen in all the samples was found to be in the non-albuminoid form.

The ash content varies from 6.73 to 23.80 percent, barring the stems of *Coprinus atramentarius*, which carried 32.58 percent. It is rich in phosphates and potash, the latter as a rule largely predominating in ten of the twelve samples. In two samples phosphoric acid is slightly in excess of the potash. Ether extract is present in comparatively small amounts, the range being from 1.21 to 5.81 percent.

But little is known regarding the food value of the fiber and undetermined carbohydrates. The small amounts of pentosans present clearly indicate the practical absence of this important group.

The variation in composition between samples of the same species, taken at different times and places, is quite marked and may indicate that the age of the specimen and the nature and abundance of the plant food present in the soil during the growth have an important influence.

ANALYSES OF INFANT FOODS.

The following analyses of infant foods were made in this laboratory under the direction of the writer by Mr. C. I. Boyden. The samples were bought from local drug stores:

	Lactated Food %	Eskey's Albuminized Food %	Peptogenic Milk Powder %	Horlick's Malted Milk %	Mellin's Food %	Cereal Milk %
Moisture	3.09	4.01	1.25	2.29	3.15	4.57
Ash	0.95	0.96	1.33	3.59	3.86	2.49
Cellulose	0.51	0.39		0.07	0.21	0.35
Fat	0.48	1.18		3.53	0.73	1.75
Protein	8.73	5.22	0.66	14.96	10.89	9.62
Lactose	21.28	45.84	98.18	8.29		27.55
Maltose	11.56	6.22		49.28	61.35	42.32
Starch	46.01	36.46		2.03	2.15	4.23
Dextrin				8.88	17.60	
Sucrose	7.18					
Material insoluble in water	54.37	44.51	0.41	7.96	8.04	10.80
Water soluble protein	1.44			11.59	4.60	4.55

The methods employed in the several determinations were obtained from sundry sources, no comprehensive work on the subject being obtainable. Wherever possible methods adopted by the Association of Official Agricultural Chemists were used.

Peptogenic milk powder made by Fairchild Bros. & Foster, New York city, is not sold as a complete food. It is used to modify the composition of cows' milk. It is practically nothing but lactose (milk sugar).

Mellin's food, manufactured by Doliber, Goodale & Co., Boston, Mass., appears to be commercial maltose, which always contains dextrine, to which has been added some material which gives the entire goods about 10 percent of protein.

Eskey's albuminized food, manufactured by Smith, Kline & French of Philadelphia, is composed mainly of lactose and starch, with relatively small amounts of maltose and protein.

Horlick's malted milk, put up by the Horlick Food Co. of Racine, Wisconsin, contains nitrogenous material, lactose, dextrin, a small amount of starch and nearly 50 percent of maltose.

Lactated food and cereal milk are manufactured by the Wells Richardson Co. of Burlington, Vt. The former contains some 46 percent of starch, together with lactose, maltose, sucrose and protein. The latter contains about 42 percent of maltose, a small amount of starch, nearly 28 percent of lactose, together with some 10 percent of protein.

ON THE QUANTITATIVE SEPARATION OF MALTOSE AND LACTOSE.[1]

BY CHARLES I. BOYDEN

The writer, in the course of a study on the composition of sundry infant and invalid foods now on the market, undertaken to fulfil a thesis requirement for graduation from the agricultural department of the University of Vermont, found it necessary quantitatively to separate maltose and lactose. He was unable to find, either in the literature or through correspondence with several chemists well informed in food analysis, any satisfactory method to this end. Such a separation may be accomplished, however, by the use of a certain variety of yeast, *Saccharomyces anomulus*, which removes maltose completely without acting on the lactose.

It is well understood that the two bisaccharides, maltose and lactose, need to be hydrolyzed before they may be fermented, and that the former yields two molecules of glucose and the latter one of glucose

[1] Reprinted from Journal of the Am. Chem. Society, Vol XXIV, No. 10, Oct. 1902.

and one of galactose as a result of hydrolysis. Glucose is then easily fermented. Yeasts usually contain hydrolytic enzymes, which are capable of changing maltose to a greater or less extent, but which are inactive with lactose.

In the course of the work carried out by the writer nine different species of yeast were used. Eight of the yeasts were obtained from Kral, and one was a pure culture from ordinary Fleischmann's bread yeast. The yeasts from Kral's laboratory were: *Saccharomyces anomolus* Hansen, *S. cerevisiae I* Hansen, *S. cerevisiae Carlsberg unterhefe I* Hansen, *S. ellipsoideus I* Hansen, *S. farinosus* Lindner, *S. Kephir* Beijerinck, *S. Marxianus* Hansen, *S. Pastorianus I* Hansen. Pure cultures of each were grow in agar, from which they were transferred to Pasteur's fluid (Strassburger and Hillhouse's formula). Samples of commercial maltose (66.36 percent maltose, remainder mostly dextrin) and lactose of known composition were used separately, as well as in mixtures of definite strengths.

From 25 to 100 cc. of of a solution of these sugars, usually 0.50 percent strong and containing 1 percent of Pasteur's mixture (Strassburger and Hillhouse), were heated at 100° C. in a steam sterilizer for thirty minutes on three successive days. The sterilized fluid was then inoculated with the particular yeast under trial and incubated at 30° C. for from two to thirty days; then again sterilized at 100° C., cooled, made up to volume, filtered, and the sugar present determined by Allihn's method. The usual precautions to prevent contamination with organisms other than the yeast under trial were observed throughout the operation from inoculation to filtration. The temperature of 30° C. was chosen, inasmuch as bread yeast appeared to act most vigorously at this temperature. The percentages of maltose removed and of lactose remaining were readily calculated from the copper reduced prior to, and that reduced subsequent to, the removal of maltose. Obviously, when working with known quantities, the completeness or the incompleteness of the removal of the maltose may be readily measured in this manner.

From about 10 percent to nearly all of the maltose remained unacted upon by eight of the yeasts. One of these yeasts, however, after a few preliminary trials completely and uniformly hydrolyzed and fermented the maltose.

S. anomolus was much the most active yeast used. It produced a heavy white growth in tube cultures in a few days. After two days' inoculation at least three-fourths of the maltose had disappeared and the proportion of maltose modified uniformly decreased up to sixteen

days after which there was no apparent change. It was found necessary to filter through a bacterial filter in order to remove the yeast cells and to prevent a precipitation of the flocculent matter by the Allihn solution, which was equivalent to a weight of from 1 to 2 percent of copper. The following table shows the result of some of the work with this yeast. The figures clearly show the relation of filtration, of the time element and of the use of the Pasteur's mixture to complete success.

Maltose taken Grams	Pasteur's mixture. Grams	Volume of solution	Solution inoculated. cc.	Days acted on	CuO from 25 cc. solution	Maltose remaining. Percent
1	2	200	50	2	0.0138	*7.47
1	2	200	50	4	0.0044	*2.38
1	2	200	50	13	0.0030	*1.63
1	2	200	50	16	0.0025	*1.35
1	2	200	50	15	0.0000	†none
1	none	200	50	11	0.0198	*10.68
1	none	200	50	34	0.0089	†4.82
1	0.5	200	50	31	0.0040	†2.16
1	1	200	50	14	0.0063	†3.42
1	1	200	50	38	0.0000	†none

* Not filtered with bacterial filter. † Filtered with bacterial filter.

It may be remarked that when this yeast was grown for from four to twenty-four days in a solution of lactose, from 98 to 100.96 percent lactose was recovered, showing that this sugar was unaltered by the yeast. It may also be remarked that the fermentation method, using *S. anomolus*, has been tried upon several of the proprietary foods upon the market; that through the courtesy of the chemist of one of the companies manufacturing this class of goods the writer has been allowed to compare analytical results with manufacturer's formulas as regards percentages of maltose and lactose; and that a reasonably close agreement has been found.

It is interesting to note that in those solutions in which the other yeasts failed—as they always did—completely to transform all the maltose, reinoculation with *S. anomolus* readily hydrolyzed and removed the remaining maltose, while in no case did it appear in any way to affect their lactose content.

Vigorous growth is needed to hydrolize the last traces of maltose. To produce this vigorous growth it is necessary to add some of the mineral elements found in the ash of yeast. Pasteur's mixture (Strassburger and Hillhouse) furnishes the necessary elements.

The method in its present form may be briefly outlined as follows: The solution containing maltose and lactose having been made approximately 0.5 percent, and containing 1 percent of Pasteur's mix-

ture, 50 cc. are heated for three successive days in a steam sterilizer, under the usual precautions, to 100° C. for thirty minutes. The fluid thus sterilized is inoculated liberally with a pure culture of *S. anomolus* and incubated at about 30° for from two to three weeks, the culture having been grown in agar and transferred to Pasteur's fluid prior to its use. After the incubation, the fluid is filtered through a bacterial filter and the copper determined in the usual manner by Allihn's method. The difference between the copper thus determined and that present prior to inoculation may be calculated as maltose, the remainder as lactose.

The writer is under obligation to the botanist and chemist of the Station for helpful advice and suggestion.

MISCELLANEOUS ANALYSES

Section 263 of the Vermont Statutes requires the station to analyze free of charge miscellaneous materials of an agricultural nature for residents of the State. Those deemed of sufficient interest to place on permanent record are here recorded.

MATERIALS FURNISHING NITROGEN

Material	From	Percent nitrogen
Nitrate of soda,	Thetford,	15.82
Nitrate of soda,	Woodstock,	15.92
Sulphate of ammonia,	W. Brattleboro,	20.97
Dried blood,	Burlington,	11.92
Dried blood,	W. Brattleboro,	14.70
Dried blood,	Westminster West,	10.50

MATERIALS FURNISHING NITROGEN AND PHOSPHORIC ACID

Material	From	Percent of nitrogen	Percent of phosphoric acid
Rawbone meal,	Burlington,	2.63	27.56
Fine ground bone,	Burlington,	2.49	25.90
Bone meal,	Hyde Park,	2.95	18.42

The raw bone used is clearly misnamed. The goods are a steamed or extracted bone, probably substituted for the raw bone meal ordered.

MATERIALS FURNISHING AVAILABLE PHOSPHORIC ACID

Material	From	Phosphoric acid				
		Soluble %	Reverted %	Insoluble %	Total %	Available %
Acid phosphate............	Burlington..................			3.05	17.86	14.81
Acid phosphate............	W. Brattleboro			1.23	17.61	16.38
Acid phosphate............	Thetford....................	11.92	4.68	0.95	17.55	16.60
Dissolved bone black......	Burlington..................			18.88	2.25	16.63

MATERIALS FURNISHING POTASH

Material	From	Percent of potash
Muriate of potash,	Burlington,	52.15
Muriate of potash,	Thetford,	56.25
Muriate of potash,	Swanton,	50.85
Sulphate of potash,	W. Brattleboro,	49.85
Sulphate of potash,	Woodstock,	50.55
Kainit,	Middletown Springs,	14.00
Kainit,	W. Brattleboro,	18.00

All the samples are up to standard and one of the muriates is exceptionally rich in potash.

WOOD ASHES

From	Soluble potash %	Insoluble potash %	Total potash %	Total phosphoric acid %	Calcium oxide %	Insoluble matter %
O. N. Kittridge, Brownsville..........	0.88	0.97	1.35	0.79	27.96	5.02
G. O. Kelton, Rutland..................	6.52	0.42	6.94	2.87	31.04	13.79
A. A. Dunklee, So. Vernon............	5.60	0.64	6.24	1.66	34.60	4.75
A. A. Dunklee, So. Vernon............	2.70	0.74	3.44	1.40	28.05	13.56
A. A. Dunklee, So. Vernon............	3.16	0.70	3.86	1.76	30.52	20.29

The first sample had evidently been leached. It carried nearly 30 percent of water when received.

The remaining samples show extensive variations in soluble potash, from 2.70 to 6.52 percent. We would suggest that purchasers of ashes submit samples to the Station for analysis before paying much money for them.

FERTILIZERS AND HOME MIXTURES

From	Nitrogen %	Soluble phosphoric acid %	Reverted phosphoric acid %	Insoluble phosphoric acid %	Total phosphoric acid %	Available ph's phoric acid %	Potash %
F. C. Nelson, W. Pawlet.......	2.49	2.35	5.39	2.93	10.67	7.74	8.35
F. C. Nelson, W. Pawlet.......	2.56				19.00		11.38
R. Bradley, Brattleboro	0.84	7.88	3.32	2.07	13.27	11.20	5.40
R. Bradley, Brattleboro	2.24	6.26	3.39	2.37	12.02	9.65	4.05
J. B. Candon, Pittsford........	2.80	6.42	4.23	3.02	13.67	10.65	2.20
Ira G. Miller, Westminster W.	6.25	1.15	3.76	1.37	6.28	5.13	12.68
A. K. Ellsworth, N.Cambridge	1.05				0.21		0.63

The second sample from West Pawlet was a mixture of ground bone and muriate of potash. The last sample was the dried residue left after washing sheep. It carried 1.43 percent water, 69 percent ash and 29.57 percent of organic and volatile matter.

For particulars regarding home mixing and fertilizers in general, the reader is referred to bulletins 93 and 99, which will be sent free of charge on request.

BUTTER FROM C. A. HASTINGS, SPRINGFIELD

	No. 1	*No. 2*	*No. 3*
Water	10.49	10.52	10.08
Fat	86.27	86.10	86.46
Curd	1.18	1.08	0.97
Salt	2.09	2.35	2.49

A sample of supposed butter sent by S. S. Rodgers of Danville, was examined and found to be genuine.

Samples of maple syrup and maple sugar sent from Danville and Barre, respectively, were examined with results as follows:

	Maple syrup	*Maple sugar*
Sucrose	54.84	83.38
Reducing sugars	10.17	0.60
Ash	0.15	0.18
Water	33.25	15.84
Undetermined	1.59	

The syrup was very dark colored and probably adulterated with cane sugar. The maple sugar was very light colored and extremely hard. Its low ash content leads us to believe that it was adulterated with liberal amounts of cane sugar.

REPORT OF THE HORTICULTURIST

W. Stuart

The writer did not assume his Station duties until the fall of 1902; hence the present report must of necessity be largely confined to a statement of investigations undertaken rather than of work completed. Of the former the following are, perhaps, the more important.

1. Greenhouse Work.—(a) Indoor studies of the effect of various chemical fertilizers in the winter forcing of lettuce, tomatoes and cucumbers.

(b) A comparison of surface and sub-watered benches in lettuce culture.

(c) Pot-grown vs. bench-grown tomato plants.

(d) Sterilization of the soil beds without removal.

II. The development of a disease resistant variety of potatoes of good quality, either by natural selection or from seedlings resulting from natural or artificial cross fertilization.

III. Observations upon the round-headed apple tree borer. *Saperda Candida. Fabr.*

The station greenhouse was placed, under the writer's direction, in a sufficiently good state of repair to permit of experimental work. This necessitated the reconstruction of about 500 square feet of bench surface, about a third of which was arranged for sub-watering, somewhat after the manner of the benches in the houses at the Indiana and Wisconsin stations.

Satisfactory results have been obtained in the several lines of indoor work mentioned above; but it is thought inadvisable to discuss the outcome of a single season's study until checked by the results during, at least, another winter.

Little can be said at present in regard to the development of a disease resistant variety of potatoes, save that the investigation is well under way and every effort will be made to attain the desired end.

Injurious Effects of the Round-Headed Apple Tree Borer

Borers are serious pests throughout the apple farming sections. An unusual opportunity having arisen for observations upon the round-headed type, the writer deems it worth while to make some brief statements as to their nature and the means of combating them, even

though, strictly speaking, it lies outside of the particular province of his line of work.

The injurious effects of the round-headed apple tree borer were very apparent in the orchards examined. In one, which consisted entirely of trees under ten years of age, a large percent of them were seriously injured and many killed outright. Others were so nearly dead that after blooming they failed to put forth leaves. One of these trees is shown in Plate I (p. 200). The base of its trunk was completely girdled by the borers. Three such trunks are shown in Plate II. Several round holes appeared a little above the girdled portion in B and C, Plate II. These were formed by the mature beetles in making their exit from the tree. A portion of the trunk of a small tree is shown in Plate I, Fig. 2, with a borer removed from its tunnel and fastened just above it. This borer was probably about two years old, and would next season have emerged as a mature beetle. A section of the trunk of one of the trees, in Plate II, appears as Fig. 3 in Plate I, showing the depth to which the borer penetrates into the heart wood, as well as the way the insect bores upwards and then outwards to the surface.

These illustrations speak for themselves. Clearly, any tree in which a borer passes its larval life is much the worse for it; and, when, as sometimes happens, eight or ten make a tree their abiding place, its usefulness is past.

While no new facts were elicted during our study bearing on the life history of this insect, and despite previous mention in former issues,[1] a brief discussion seems pertinent.

HISTORICAL

The round-headed apple borer (*Saperda Canida Fabr.*) was first recorded by Thomas Say in 1824. It is, however, quite probable that it was prevalent in the apple orchards of America long before this date, as it is supposed to be a native of this country. Its ravages are not confined solely to the apple, as it may be found in the crab apple, pear, quince, and other Rosaceae.

DESCRIPTION [2]

"*Eggs.*—Minute, yellowish white.

Larva.—When full grown, about one inch long; footless, yellowish white. Head small, chestnut brown, polished, hornlike, jaws two, black; the second joint large and broad, the next two narrow. Rings

[1] Vt. Sta. Bul. 60, pp. 14-16, (1897).
[2] Harvey, Me. Sta. Rpt. 15, p. 100 (1899).

of the body (segments) from the fourth to the tenth inclusive, armed on the upper side with two fleshy warts.

Pupa.—Lighter-colored than the larva and with transverse rows of minute spines on the back.

Perfect insect.—A beetle about three-fourths of an inch long, with two broad white stripes extending from the head to the ends of the wing cases; cinnamon brown above; hoary white below; legs, attennae and face whitish."

LIFE HISTORY

The eggs are laid in slits made by the ovipositor of the mature beetle in the green bark of the trunk of the tree, at or near the surface of the ground. They may be deposited as high as eighteen inches, but usually are found nearer the base. The eggs are either laid in the bottom or pushed into the side of the slit under the bark, the latter seeming to be a favorite method. They are probably deposited in this latitude from the middle of June to the latter part of August. Observations in Maine have shown that they are deposited from June to September. The egg soon hatches and the young larva begins at once to gnaw its way through the inner bark and cambium layer. On the approach of winter it tunnels its way down the trunk of the tree below the surface of the ground. With the advent of spring it ascends and passes the summer in the sap wood. The second winter is passed in a similar manner to that of the first. The third season the larva again ascends and bores or gnaws its way into the heart wood of the tree, and in all directions. Towards the close of the season it gnaws its way upward and outward to the bark of the tree, after which it withdraws into its burrow, encases itself with the castings of wood and soon enters into the pupal stage of its existence. Early in the next June it cuts its way out, emerges as a mature beetle, the female deposits its eggs and the life cycle is completed.

PREVENTIVE MEASURES

The sundry measures recommended looking towards prevention are of two classes. They looked either to the exclusion or the repulsion of the insect. It is either shut away or turned away from the tree trunk.

Exclusion.—This method of combatting the borers seems to the writer to be the more hopeful if the work is carefully done. Various materials may be used for wrapping the trunk, such as heavy wrapping paper, manila paper, tar paper or fine wire screen. Their efficacy is entirely dependent on the care and skill with which they are put on. To be effective they must fit sufficiently close to the trunk and come up high enough to prevent the beetle from deposit-

ing its eggs. The material used in fastening the wrappers should be such as is easily broken by the growth expansion of the tree. The employment of tar paper or fine wire netting serves the double purpose of excluding insects and protecting the trunks from injury by mice, rabbits or other small rodents. One objection sometimes urged against wrapping the tree trunk with heavy paper, is that, upon its removal, it renders the tree more subject to sun scald. Another, which might be raised, is that unless examined occasionally, the wrapper is apt to get disarranged and instead of being a protection it may serve as a screen for the insects.

Repulsion.—The application to the tree trunk of some caustic or ill-smelling compound serves to repel the borer in proportion to the thoroughness with which it is used and the persistency of the retention. Most of the washes employed are of an alkaline nature, consisting of soaps, or lyes, caustic in their action, to which, frequently, enough carbolic acid is added to give an offensive odor. Quite recently painting the tree trunks with pure white lead and linseed oil has been highly recommended by Alwood of the Virginia station, as being an effective repellant of the round-headed apple-tree borer. The ease of application and the persistency of the material should warrant its trial on a small scale in this latitude. Various patent washes have been from time to time widely advertised. Most of these compounds contain coal-tar products, which, while ill-smelling enough, are more or less injurious to the trees. Such are not, as a rule, to be recommended. It is evident that the protection of the trunk by washes can be effective only when it is kept covered with it.

Remedies.—After the larva has entered the tree, there is practically but one thing to do. It must be dug out. A strong bladed knife and a rather strong, flexible wire are the only tools required. It is usually stated that it is sufficient to go over the trees twice yearly, in May and September. The writer recommends that, in badly infested orchards, at least, a further inspection be made in July. Many of the newly laid eggs could then be destroyed. The presence of the young larva in the tree is usually easily detected, since they lie near the surface and generally cause a slight flow of sap from the wounded tissue. The bark, moreover, is usually somewhat discolored. They are easily reached at this stage of their development, and, if destroyed, cause but little injury to the tree. As they grow older they advance deeper into the wood and their presence can only be detected by the fresh castings that are pushed out as they gnaw through

the wood tissues. The knife is used to remove the castings which clog the tunnel and then the flexible wire is inserted. If the course of the larva is not too devious one can generally succeed in destroying it. The work of removing a two or three year old larva is, of course, much more laborious than that of getting rid of the younger ones located nearer the surface. And, moreover, their presence in the tree is less readily detected. Orchards which have been carefully gone over twice during each season, from the time of planting, will contain few, if any, larva of the second or third season's growth.

Carbon bi-sulfid is recommended by some for the destruction of borers in the tree. A small amount of this substance is inserted into the tunnel of the borer and the hole stopped up with moist earth, or, better, with grafting wax. This method while effective, and, if used judiciously, not harmful to the tree, does not seem to the writer practicable. At all events it is not a remedy to be recommended without qualification. Carbon bi-sulfid is somewhat expensive, and exceedingly explosive. It should be kept from flame and the fumes should not be breathed.

SUMMARY

Borers in the apple orchard are a serious menace to the trees. They should be promptly removed.

The exclusion by the means of heavy paper or fine wire screen is effective only when properly done. It may otherwise prove worse than no protection.

Repellants of all kinds are of service only when persistently used, and at best do not insure absolute protection. Patent washes are apt to prove injurious to the trees.

Digging out the borer with knife and wire is effective, but laborious.

Carbon bi sulfid intelligently used may be serviceable, but is a dangerous remedy in careless hands.

DAIRY FEEDING

J. L. Hills

The main source of income on fifty-one percent of Vermont's farms is derived from the sale of dairy products. It is the mainstay of from 27 to 33 percent of the farms in other New England states and New York, and of from 15 to 17 percent of those of New Jersey, Pennsylvania and Wisconsin. These data tell no new story; but they are an ample justification of the old-time policy of this Station which places dairy investigational work well to the front. Extensive feeding trials are an annual feature, trials designed to investigate methods of experimentation as well as to furnish data concerning food values; herd records are maintained and reviewed; and various minor matters are from time to time examined.

The experiments completed and written up since the fifteenth report was issued are discussed under the following headings:

Feeding trials with cows.

- I. Introduction.
- II. Statement of methods and details of account of conduct of the feeding experiments.
- III. Is two pounds of grain feed daily enough?
- IV. Distillers' dried grains, clear and diluted with bran.
- V. Distillers' dried grains and brewers' dried grains.
- VI. Distillers' dried grains and cottonseed and linseed meals.
- VII. Brewers' dried grains and cottonseed and linseed meals.
- VIII. The feeding value of pumpkins.
- IX. Nutrene.
- X. Distillers' dried rye grains.
- XI. Experimental error.
- XII. Summary.

A comparison of feeding trial methods. (Third article.)
Records of the station herd for 1902-03.
What kind of corn shall be planted for silage in Vermont?
How long may a finished Babcock test be preserved unimpaired?
Appendix containing condensed data pertaining to the article on "Feeding trials with cows."

FEEDING TRIALS WITH COWS

This aticle is summarized at its close, some 40 pages further on. The results of the trials are concisely stated therein and cross references are given.

I. INTRODUCTION

The general line of feeding tests begun six years ago has been followed in the work of the past season. Some of the trials are repetitions of those made last year and discussed in the fifteenth report, it being our settled policy to carry out at least two years' tests of all important matters. Still others are in continuation of work done for several years past. Some stress has been laid upon the comparison of the relative food values of sundry rations, but not to the exclusion of the consideration of important fundamentals in dairy feeding.

The equipment of the station is in many ways well adapted to this line of work. The large size of its herd, for example, permits wide range in the choice of animals, much repetition of work, and the conduct of a relatively large number of trials at one time.

The feeding experiments of the past winter were designed to aid in the answering of the following questions:

(a) What is the effect on the quantity and quality of milk and on the economy of production of a very low, of a low and of a medium grain ration? In times when grain feeds rule high may two pound grain rations prove economical?

(b) Can eight pounds of distillers' dried grains be fed daily with safety? Is it an economical practice, or are they better diluted?

(c) What are the relative feeding values of the distillers' dried grains and the brewers' dried grains?

(d) What are the relative feeding values of distillers' dried grains and cottonseed and linseed meals?

(e) What are the relative feeding values of brewers' dried grains and cottonseed and linseed meals?

(f) Can apple pomace be fed liberally with safety? Does increased profit parallel its increased use?

(g) What is the feeding value of pumpkins?

(h) What is the feeding value of distillers' dried rye grains?

(i) Is "Nutrene" a desirable addition to the list of dairy feeding stuffs?

(k) What is the extent of experimental error in feeding trials?

II. STATEMENT OF METHODS AND DETAILS OF CONDUCT OF THE FEEDING EXPERIMENTS

The records of 53 cows were kept in the six months duration of the feeding trials. Forty-eight of these records are deemed safe to use. But little sickness interfered with the trials. The results of certain periods with some cows were rendered useless because of temporary illness, of early drying off, or because the animal went off feed. It was not strange that some minor misfortunes of this kind should occur to affect results in individual cases, since 53 cows were fed for from 105 to 175 days under conditions which involved many, and, often, radical changes in the character or the quantity of their rations. No seriously disturbing factor common to the entire herd was noted. Nutrene (Feed 5) was refused by all but one cow, thus limiting the data available for determining its value. Clear distillers' grains (Feed 4) was not always eaten with avidity.

One very unfortunate error was made, the result of which was lamentable. A farm hand through misunderstanding used the rye grains (the XX brand of distillers' grains) instead of the alcohol grains (the XXXX brand) in making a mixture of the No. 3 feed about Christmas time. The former carry 20 percent, the latter 35 percent of crude protein. Two-thirds of the feed, by weight, was composed of this by-product. This erroneous mixture was fed for nearly a month, mainly in the second period. The error was not discovered until disclosed by analytical discrepancies when the feeds were analyzed early in the following summer. This unhappy occurrence naturally nullified all the data gathered in periods I and II for cows fed No. 3 in either period. Since the record of period II links with that of period IV in the reckoning of "differences" two of the three comparisons possible for each cow fed No. 3 feed during the winter were made useless. The distillers dried grains were *the* prominent feeding stuff of the winter's trials. Both the nature and the time location of the mishap were such as caused a maximum of mischief. Over a third of the total number of comparisons which otherwise would have contributed to the final results of this as well as the succeeding article had to be rejected limiting seriously the available data. Spilt milk is proverbially not worthy of tears, and spoilt milk records need no further display of ink; but one cannot help mourn over the destruction wrought by the error of a moment.

The 48 cows whose records are available for use were distributed among the several tests as follows:

(a)	Very low, low and medium grain feeding	12
(b)	Distillers' grains clear and diluted with bran	4
(c)	Brewers' grains and distillers' grains	6
(d)	Distillers' grains vs. cottonseed and linseed meals....	6
(e)	Brewers' grains vs. cottonseed and linseed meals....	5
(f)	Apple pomace silage fed freely vs. corn silage	8
(g)	Apple pomace silage vs. pumpkins	4
(h)	Nutrene	1
(i)	Distillers' rye grains or cottonseed and linseed meals	1
(k)	Experimental error	1
		48

All the cows were not equally well suited to our purposes as regards time of lactation. A long and careful study of previous records—extending over nearly nine years with some animals—of ages, times of calving, flow and quality of milk, times of service, etc., prefaced choice for the various experiments. Preference in selection was on the whole given to the trial of the varying amounts of grain.

DETAILS OF FEEDING

The feeding periods were five weeks long. The first 12 days were always considered preliminary and non-experimental while the last 23 were chosen as the experimental portion. The experimental portions only of the periods are considered in the discussion, and are hereafter referred to as "the period." The conclusions drawn are based solely upon the results obtained during these 23-day periods. The preliminary portions were considered as preparatory only, as being necessary to get the animal fairly upon and accustomed to its new diet when change was made therein. For the sake of uniformity and for the purpose of rendering comparisons more strict, the same separations into preliminary and experimental portions were made with the records of those animals which were uniformly fed. Although but of incidental use, full feeding and milk records were kept, samples of fodders and feeds and milk taken, and analyses made, in the same manner and with the same care during the preliminary as during the experimental portions of the periods. All the calculations have been made for the preliminary as well as for the experimental portions. This enables a constant check to be kept upon the progress of the trials and more clearly shows faults if such exist.

The cows were fed twice daily, watered twice, and turned out into the yard twice. The yard exercise varied in duration from 15 to 30

minutes according to the weather. Hay was first fed morning and night; after this was eaten, as much silage was given as the cow would consume; and then the grain was fed. The amount of hay offered each cow was in the main uniform throughout the test. The amount fed naturally was varied between cows according to their ability to consume it. All fodders and feeds were weighed as fed. The uneaten food was weighed back daily and its nature noted.

FEEDING PLAN OF ALL TESTS

The formulas, digestible constituents, etc., of the mixed feeds numbered 1 to 7, and of the grain feeds and by-products from which they were formed, as well as of the roughages used are shown on pages 221-222. It may be said in brief, that Nos. 1 and 7 carried two-thirds and Nos. 2 and 3 one-third their weight of bran, the remainder being made up as follows: No. 1, one-half cottonseed and one-half linseed meals; No. 7, one-half cottonseed and one-half corn meals; No. 2, dried brewers' grains; No. 3, dried distillers' grains. Feeds numbered 4, 5 and 6 were unmixed goods, being respectively dried distillers' grains, Nutrene and dried distillers' rye grains.

All cows received hay in amounts ranging from 12 to 20 pounds daily, and silage (except in trials involving changes in this material and in the use of pomace or pumpkins) in amounts ranging from 12 to 30 pounds daily.

The changes in daily grain feed were as follows:

(*a*) *Very low, low and medium grain feeding;* seven cows, continuous feeding on either mixed feeds 2 or 3, amounts varying either from 2 to 8, or from 4 to 8 pounds daily; five cows, the same, amounts remaining constant throughout at either 2 or 4 or 8 pounds daily.

(*d*) *Distillers' grains vs. cottonseed and linseed meals;* two cows fed Nos. 3 and 4 alternately, one cow fed No. 4 continuously.

(*c*) *Brewers' grains and distillers' grains;* three cows fed Nos. 2 and 3 alternately; two cows fed No. 2, and one cow fed No. 3 continuously.

(*d*) *Distillers' grains vs. cottonseed and linseed meals;* two cows fed Nos. 1 and 3 alternately; two cows fed No. 1, and two fed No. 3 continuously.

(*e*) *Brewers' grains vs. cottonseed and linseed meals;* three cows fed Nos. 1 and 2 alternately; one cow fed each No. 1 and No. 2 continuously.

(*f*) *Apple pomace silage ad lib. vs. corn silage;* six cows fed these silages alternately; one cow fed each continuously.

(*g*) *Apple pomace silage and pumpkins;* four cows fed each alternately.

(*h*) *Nutrene;* one cow fed continuously.

(*i*) *Distillers' rye grains vs. cottonseed and linseed meal;* one cow fed Nos. 1 and 6 in alternation.

(*k*) *Experimental error;* one cow fed No. 1 continuously.

The twenty-two cows fed continuously in tests (*a*) (*b*) (*d*) and (*e*) furnish data for use under (*k*).

The heifers were fed six pounds of grain daily, the other cows eight pounds daily unless otherwise stated.

Comparisons of the amounts of nutrients eaten by the various cows with the Wolff and the Wolff-Lehmann standards show that while there were wide variations in eating as between the different cows and rations there was generally eaten enough and to spare of each of the ingredients. In fact it may be said in general that the feeding was liberal and equal to the standard needs of cows a hundred pounds or more heavier. When the very low and low rations were fed too little protein was consumed. In most cases, however, the amount of this latter nutrient eaten approximated, and, indeed, often exceeded that called for by the standards. More specific statements touching these comparisons are made in the discussion of each test.

WEIGHTS OF COWS

All of the cows used were weighed during the first three days of the opening period, and on the last three days of all periods. Average weights are shown in table I of the appendix. Rather more than half of the number gained more or less in weight during the winter; rather less than half held their own—with more or less fluctuation—; and two cows lost weight. The causes of variation in live weight are many and obscure, and a survey of the data is not very enlightening. There appear, however, to have been some general tendencies. A lessened live weight followed a shortened grain ration and an increased weight a larger ration nearly three times as often as when the reverse result occurred. Atalanta, continuously fed a 2 pound ration for six months lost nearly one hundred pounds in live weight.

BARN TEMPERATURES

The cows were stabled in two portions of the barn structure, the temperatures of which were taken daily at 5 A. M., 12 M., and 6 P. M. The exposed location of the Station barn causes considerable fluctuation in the temperature of the cow stables during the winter, notwithstanding the comparatively large number of animals housed therein.

The average barn temperatures, morning, noon and night, during each period, the ranges of variations, and the percent of the entire number of observations within 3° F. of the mean of each period are tabulated in the appendix. Careful comparisons of variations in milk yield with temperature changes which extend over three or more days were made and no material changes discovered in the flow which seemed accountable to the temperature. Indeed the results of eight years of experimentation lead the writer to believe that the effect of temperature variations—within reasonable limits—upon the milk flow has been overestimated. No doubt more uniform barn temperature than is attainable under our conditions would have been an advantage; but it is judged from these comparisons, as well as from a large amount of study given to this matter in former years, that such temperature variations as occurred had little if any effect on the final results. It should be noted, moreover, that, since all the cows were housed together, these effects, if any, might be expected to be uniformly exerted on all; and that in every trial cows were being alternated on feeds, there being some fed on each ration at all times. It should be remembered also in this connection that all the cows were turned out daily for from 15 to 30 minutes.

DATES OF FEEDING PERIODS

I Preliminary Dec. 3-15.
Experimental Dec. 15-Jan 7.

II Preliminary Jan. 7-19.
Experimental Jan. 19-Feb. 1.

III Preliminary Feb. 11-23.
Experimental Feb. 23-Mch. 18.

IV Preliminary Mch. 18-30.
Experimental, Mch. 30-Apr. 22.

V Preliminary Apr. 22-May 4.
Experimental May 4-27.

MILKING AND MILK SAMPLES

Every milking was weighed from the outset to the end of the feeding trials. Composite samples of nine milkings each were taken continuously throughout both the preliminary and the experimental portions of the periods, with the exception of one day in the middle of the preliminary portion of each period. These were analyzed by the Babcock centrifugal method for fat, while the total solids were furnished by the Quevenne lactometer, the Hehner and Richmond formula ($T=1.2\ F+\frac{L}{4}+0.14$), the fat percentage and the milk slide-rule.

FODDERS AND FEEDS

The silages and feeds were sampled thrice each period. The hays, separate lots from the main and from the annex barns. were sampled twice a week. There were taken in all 360 samples of roughages and

of concentrates, silages in triplicate, hays in duplicate, concentrates singly. All samples were individually analyzed for their dry matter content, and were then combined to make 45 composite samples for complete analysis. Tables of analyses, of digestion coefficients, and of digestible nutrients appear in the appendix; the averages of these are shown on a few pages further on.

The hay fed was in general a good grade of early-cut hay of mixed grasses, mostly timothy, with considerable clover. So many cows were fed for so long a time that it was impossible to secure an absolutely even grade of hay for use throughout the trials. In order to keep check on the character of the hay fed and to prevent too great variation in the ration, samples were taken every three days and nitrogen determinations made at once. Some few divergences occurred. The variations, however, were not extreme enough seriously to disturb the conduct of the trials, yet they were wider than could have been wished. Hence it is felt that the averages given in the tables as well as the figures shown in the appendix and actually used, are entirely safe as indicating the quality of the hay eaten.

The silage was made from Sanford corn. It kept well and was not very acid, though a little more so than could have been wished.

It will be remembered that the summer of 1902 was inordinately wet. Much of the corn failed to mature and the dry matter content of the silage and its feeding value were much impaired.

The bran was roller process, Pillsbury make. Dried brewers' grains and dried distillers' grains are kiln-dried by-products of the brewing and distilling industries. Three brands were used. The Biles XXXX and the Mohawk Dairy Feed were quite similar so far as analyses indicate. The XX (rye) grains were poorer poor in protein. The character of the other feeding stuffs is sufficiently indicated by their names. "Nutrene," fed to several but relished and eaten by but a single cow, is a molasses-oat refuse by-product. The mixed feeds were made from time to time as needed in accordance with the formulas shown in the foot-note on the next page.

RECORDS OF THE FEEDING TESTS

The experimental feeding and care of 50 cows for from three to six months involved a vast amount of labor. It necessitated about 50,000 barn weights and records, and analysis of 600 samples of fodders and feeds for dry matter, of 40 similar materials for the various crude nutrients (complete analysis) and of about 1300 composite samples of milk for fat and specific gravity. And, finally, many hundreds of

hours of work were spent in the collation and calculation of the multitudinous records of the tests in preparation for publication. All the mathematical work in connection with this, as with all other similar station work, was done in duplicate, often by different persons, was cross-checked wherever possible, and was accomplished so far as might be with the aid of calculating instruments and tables. It is thought to be absolutely accurate. The detailed data if printed would well nigh double the size of this report. Even when condensed into the briefest possible compass it occupies much space. Our usual custom of placing in an appendix the condensed data which form the basis for the conclusions has been followed in the present case. It is there of ready reference to those interested, but does not stand in the way of that larger class of readers who care only for the text and for the smaller tables showing final results. Only such tabular matter as is needed to explain the text is included in the body of the articles. The main tables appeaar in the appendix to this volume under the following headings:

APPENDIX CONTAINING CONDENSED DATA PERTAINING TO ARTICLES ON FEEDING TRIALS WITH COWS

I. Weights of cows.

II. Average barn temperatures, with ranges and percentages of uniformity.

III. Analyses and digestible ingredients in fodders and feeds; (*a*) analyses on dry basis; (*b*) digestion co-efficients; (*c*) pounds of digestible nutrients in 100 pounds of original substance.

IV. Feeding records of the individual cows in feeding tests.

V. Production records; showing production and same per unit for each individual cow in feeding tests.

VI. Difference tables. (*a*) Totals of differences; (*b*) Percentage differences.

VII. Results of experimental feeding on different rations.

This appendix is omitted in the general edition, since it is composed simply of a mass of figures, of interest mainly to the student of animal husbandry and as a matter of record showing the basis for the conclusions drawn from these trials. Copies may be obtained on application by such parties as may desire it. It is printed in the edition sent to the experiment station and library mailing lists.

PERIODS AND COWS

The following periods show the periods, dates and the cows in use, with the nature of the grain feed eaten during each period. The names which are italicised are those of registered Ayrshires, the small capitals indicate registered Jerseys, while the names given in ordinary type are those of high grade Jerseys.

The abbreviations in the table may be explained as follows: "Med." indicates that a medium 8 pound daily ration was fed to mature cows and a 6 pound one to heifers; "v. low," that a 2 pound daily grain ration was fed; and "low," that a 4 pound daily grain ration was used. The abbreviations "pom," "corn," and "pump," refer respectively to the use of apple pomace silage, of corn silage and of pumpkins. The arabic numerals in the columns headed I to V refer to the feed mixtures which, as hitherto explained, were made up by weight of:

No. 1. Wheat bran, 4; cottonseed meal, 1; linseed meal, 1.
No. 2. Wheat bran, 1; dried brewers' grains, 2.
No. 3. Wheat bran, 1; dried distillers' grains, 2.
No. 4. Clear dried distillers' grains undiluted with other feed.
No. 5. Nutrene dairy feed.
No. 6. Wheat bran, 1; dried distillers' rye grains, 2.
No. 7. Wheat bran, 4; cottonseed meal, 1; corn meal, 1.

COWS USED AND NATURE OF GRAIN RATIONS, ETC., FED DURING EACH PERIOD

Name	Approximate age Nov. 1, '02	Calved 1902 or 1903	Served 1902 or 1903	Feed	Period numbers I	II	III	IV	V
VERY LOW, LOW AND MEDIUM GRAIN FEEDING									
Pomona	11	Dec. 9	March 16	No. 2	med.	v. low	med.	v. low	med.
Lucerne	9	Oct. 11, '02	Jan. 31	"	v. low	med.	v. low	med.	v. low
MAX BELLE	10	Nov. 4, '02	July 7	"	med.	med.	med.	med.	med.
Atalanta	13	Aug. 1, '02	Feb. 7	"	v. low	v. low	v. low	v. low	v. low
Maid Marian	9	July 2, '02	March 21	"	low	v. low	low	v. low	low
Elsa	5	....	Nov. 30	"	v. low	low	v. low	low	v. low
Flora	13	July 29, '02	Dec. 27	"	low	low	low	low	low
Eunice	5	Dec. 3, '02	March 11	No. 3	....	....	med.	v. low	med.
Fresno	4	Dec. 2, '02	Feb. 6	"	....	....	v. low	v. low	v. low
Inez	10	Nov. 29, '02	March 15	"	....	....	v. low	v. low	v. low
LADY PERUSIA	9	Nov. 28, '02	May 4	"	....	....	low	v. low	low
Linnet	2	Jan. 28, '03	N't served	"	....	....	v. low	low	v. low
DISTILLERS' GRAINS									
Serena	6	Nov. 20, '02	May 9	......	....	4	3	4	3
Stella	5	Nov. 28, '02	March 14	......	....	4	4	4	4
Sonoma	4	Jan. 10, '03	April 5,	......	....	....	4	3	4
Monterey	4	May 26, '02	Oct. 29	......	....	4	3	4	....
BREWERS' AND DISTILLERS' GRAINS									
Janice	6	....	Jan. 10	......	....	2	3	2	3
Vivian	7	....	Nov. 16	......	....	....	3	3	3
Juanita	5	Aug., '03	Oct. 29	......	....	....	2	3	2
Katrina	2	Sept. 27, '02	March 18	......	2	2	2	2	....
BEAUTINA	11	Feb. 11, '02	Sept. 6	......	....	2	3	2	....
Bertha	3	April 9	Jan. 8	......	2	2	2	2	....
COTTONSEED, LINSEED AND DISTILLERS' GRAINS									
Primrose	10	Jan. 7, '03	N't served	......	....	....	1	3	1
Rosemary	8	Jan. 4, '03	April 4	......	....	1	1	1	1
Goldenrod	11	July 31, '02	March 24	......	....	1	3	1	3
Rosel	6	June 7, ,02	Nov. 19	......	....	....	3	3	3
Lavender	5	Farrow	Oct. 26	......	1	1	1	....	....
Pretoria	6	Sept. 29, '02	Feb. 15	......	....	....	3	3	3
COTTONSEED, LINSEED AND BREWERS' GRAINS									
Star Bright	6	*Sept. 21	July 6	......	2	1	2	1	2
Ursula	6	Aug., '02	Dec. 2	......	2	2	2	2	2
Dorothy	3	Feb. 14, '03	July 4	......	....	....	1	2	1
Edith	5	Jan. 25, '03	July 19, '03	......	....	....	1	1	1
Lorna Doone	3	Feb. 24	Nov. 18	......	1	2	1	2	....
CORN AND POMACE SILAGES									
Santa Clara	4	May 16, '02	Oct. 20	......	pom.	corn	pom.	corn	pom.
MINTA BELLA	11	June 7	Aug. 3, '02	......	corn	corn	corn	....	....
Mermaid	7	Feb. 11, '02	Sept. 4	......	corn	pom.	corn	pom.	....
Eva	10	Jan. 1, '02	Sept. 2	......	pom.	pom.	pom.	....	....
Ceres	12	Jan. 6, '03	March 20	......	....	corn	pom.	corn	pom.
Santa Rosa	4	July 16, '02	Nov. 6	......	....	corn	pom.	corn	pom.
Yuba	4	July 29, '02	Jan. 14	......	....	corn	pom.	corn	pom.
Naomi	7	Dec. 25, '01	April 23	......	....	pom.	corn	pom.	....

*Aborted.

Name	Approximate age Nov. 1, '02	Calved 1902 or 1903	Served 1903 or 1903	Feed	Period numbers I	II	III	IV	V
PUMPKINS; POMACE									
Acme	13	Mar. 25, '02	Jan. 3		pom.	pump.	pom.	pom.	pom.
Nancy B.	15	Apr. 24, '02	Oct. 25		"	"	....	....	....
Hallowe'en	9	Apr. 30, '02	March 14		"	"	....	....	....
Mona	5	*June 7	April 16		"	"	....	....	....
Dahlia	11	May 13	Aug. 1		1	6	1	....	....
Powella	10	Mar. 13, '02	Farrow		5	5	5	5	5
Una	3	Dec. 12, '01	Aug. 3, '02		1	1	1	....	....

*Aborted.

AVERAGE ANALYSES OF FODDERS AND FEEDS

Fodders and feeds	Original substance: Water	Original substance: Dry matter	Composition of dry matter: Crude ash	Crude protein	Crude fiber	Nitrogen-free extract	Ether extract	Nitrogen	Phosphoric acid	Potash
Hay (main barn)	13.42	86.57	8.32	10.04	33.40	46.29	1.94	1.61	0.62	2.28
Hay (annex barn)	12.37	87.63	8.12	9.75	36.20	44.17	1.76	1.56	0.58	2.48
Corn silage	77.92	22.08	7.68	9.35	2[illegible].66	54.91	2.40	1.49	0.69	2.11
Apple pomace	75.63	24.37	4.79	7.22	18.23	64.56	5.19	1.16	0.46	0.98
Pumpkin pomace	87.90	12.10	9.28	10.86	13.76	61.59	4.51	1.74	1.20	3.78
Mixed feed No. 1	11.35	88.65	7.90	26.89	10.48	48.65	6.10	4.31	3.11	1.88
" " " 2	11.40	88.60	6.14	25.22	13.83	49.01	5.82	4.04	1.93	0.84
" " " 3	9.63	80.37	4.29	30.45	13.54	41.81	9.91	4.87	1.37	0.80
" " " 6	10.98	89.02	4.27	19.94	14.52	53.16	8.11	3.19	1.53	0.95
" " " 7	12.55	87.45	7.45	23.46	9.06	54.61	5.42	3.76	2.77	1.87
Wheat bran	12.15	87.85	8.02	17.89	10.83	58.22	5.06	2.86	3.13	1.94
Cottonseed meal	7.84	92.17	8.61	49.06	5.34	26.62	10.38	7.85	3.54	2.20
Linseed meal	10.51	89.49	6.31	42.37	8.78	38.74	3.80	6.78	2.12	1.40
" "	11.10	88.90	5.68	38.94	8.74	38.94	7.70	6.23	1.84	1.31
Dried brewers' grains	7.12	92.88	4.65	32.03	13.95	43.37	6.00	5.13	1.08	0.84
" " "	14.30	85.70	5.04	26.06	16.27	47.58	6.05	4.01	1.08	0.09
Dried distillers' grains (1)	8.62	91.38	2.47	37.94	11.57	32.77	15.25	6.07	0.74	0.40
" " " (2)	8.75	91.25	2.57	38.30	13.32	33.88	12.43	6.13	0.71	0.28
" " " (3)	9.92	90.08	2.80	20.52	15.26	52.37	9.05	3.28	0.75	0.45
" " " (2)	8.25	91.75	2.49	36.25	13.25	36.59	11.42	5.80	0.55	0.13
Nutrene	12.55	87.45	15.31	19.12	21.11	41.02	3.45	3.06	1.67	1.31
Corn meal	16.45	83.55	2.18	11.28	21.13	32.56	1.86	1.81	0.80	0.40

(1.) Mohawk Dairy Feed.

(2.) Biles XXXX (alcohol) grains.

(3.) Biles XX (rye) grains.

AVERAGE DIGESTIBLE INGREDIENTS IN FODDERS AND FEEDS.

Fodders and feeds	Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract
Hay (main barn)	51.9	5.0	16.8	25.6	1.0
Hay (annex barn)	52.6	4.9	18.4	24.8	0.9
Corn silage	16.1	1.3	4.8	9.4	0.4
Apple pomace silage	17.6	...	2.7	13.2	0.5
Pumpkins	No basis for assumption				
Mixed feed No. 1	59.4	19.8	3.6	30.6	4.3
" " " 2	55.0	17.7	5.8	26.9	4.4
" " " 3	67.4	19.6	10.0	30.9	7.3
" " " 6	69.9	18.1	9.7	38.5	5.9
" " " 7	60.4	16.6	2.5	35.8	3.7
Wheat bran	54.5	12.3	2.8	35.3	3.0
Cottonseed meal	68.3	39.8	2.8	15.0	8.9
Linseed meal	70.7	32.2	6.3	29.8	3.3
" "	70.2	29.4	6.2	29.8	6.6
Dried brewers' grains	57.6	23.5	6.9	23.4	5.1
" " "	58.1	17.0	7.4	23.6	4.7
Dried distillers' grains (1)	73.1	25.3	10.6	25.4	12.7
" " " (2)	73.0	25.5	12.1	25.9	10.3
" " " (3)	72.1	18.5	13.4	40.1	7.4
" " " (2)	73.4	24.3	12.2	28.5	9.6
Nutrene	No basis for assumption				
Corn meal	74.4	6.4		65.5	1.5

(1.) Mohawk Dairy Feed.
(2.) Biles XXXX (alcohol) grains.
(3.) Biles XX (rye) grains.

III. IS TWO POUNDS OF GRAIN FED DAILY ENOUGH?

The question as to the best amount of grain to feed a cow, viewed from the standpoint of profit as well as from that of the animals continued well being and usefulness, has been in review at this Station for four years. The results of the inquiry have been published in former reports.[1] Different rations have been fed which carried 4, 8 and 12 pounds of grain fed daily. The outcome—speaking broadly— has not favored the heavier ration, which, when the home-grown roughages were freely used, was always fed at a financial loss. The low, four pounds, ration, however, if looked at simply from the viewpoint of dollars and cents, quite often proved superior to the medium eight pound feed. In other words, when early cut hay, containing considerable clover, and well matured, well eared corn silage were fed in fairly liberal quantities, the extra milk, butter, and manurial value, produced by feeding eight pounds of grain a day instead of four, was

[1] Vt. Sta. Rpt., 13, pp. 402-417 (1900); 14, pp. 325-340 (1901); 15 pp. 280-300 (1902).

at times insufficient to pay the extra cost of the grain. When it did meet this cost, it seldom exceeded it to any extent. It is felt, however, that when the continued usefulness of the cow as a milk maker is considered that a somewhat more liberal grain ration than a four-pound one affords is generally to be preferred, particularly if the roughages are inferior in quality or lacking in quantity. However, the four-pound grain ration has certainly proved very satisfactory in several trials; and the question arises whether or not the limit has been reached. If four pounds has proved a fairly satisfactory ration to use, might not three pounds do about as well? And how about a two-pound ration?

The high prices lately ruling for grain have forced many dairymen to curtail their purchases. These heavy charges have also, and most fortunately, impelled many to study the relative values of the different grain feeds, and to make wiser purchases than hitherto. And they have made it more imperative than ever before that, if practicable and possible, the question of the lowest limit of the profitable use of grain feed for cows be determined. Prominent dairymen engaged in institute work, men who have made a success in their calling, are preaching the doctrine—and practicing it—of a two-pound or less daily grain ration for cows, claiming that so long as prices ruled high, they did not get a dollar back for a dollar expended on a larger amount of grain.

It seems to the writer in view of these conditions that it is well worth while to try and accumulate data which will contribute to the rational solution of this question. It is thoroughly appreciated that no one trial can settle it; that the character, quality and quantity of the roughages used, and the individuality of the cows, as well as that of the feeder, enter into the problem; that, in short, circumstances so markedly alter cases that the outcome of these trials or, if confirmed by further tests, of several trials would not be necessarily duplicated elsewhere by other feeders. The results of these trials then simply afford so much testimony as to the advisability of feeding very low grain rations, testimony which may or may not be confirmed by other witnesses.

FEEDING

It seemed best to try two different grain rations; to use two methods of measurement, the alternation and the combined continuous-alternation system; and to compare the very low grain ration not only with a low, but, also, with a medium one. Consequently Nos. 2 and

3, the brewers' grains and the distillers' grain mixtures, were used; a considerable number of cows—twelve—were employed; and three different amounts of grain, 2, 4 and 8 pounds daily, were fed. Some cows were fed continuously 2 pounds daily throughout the course of the trials, others 4, and still others 8 pounds. Some cows alternated one period with another from 2 to 8 pounds, and others from 2 to 4 pounds. None alternated from 4 to 8 pounds, as the comparison between low (4 pound) and medium (8 pound) rations was not an issue in this set of trials.

It was expected to use 16 cows in these trials. Three came in later than they were expected to; and one cow protested against the No. 2 feed, the only one which has ever done so in our experience. The error in mixing the No. 3 feed, hitherto alluded to, also interfered very greatly. Consequently the available data is much less than was expected.

Ten of the twelve cows used were within two months of calving when the trials started, and the other two were 4 months along in milk.

COMPARISON WITH STANDARDS

Wolff. Very low ration. Ten cows ate this ration. Seven were fed a very insufficient amount of dry matter, two ate somewhat too little, and one, Elsa, a hearty consumer of roughages, a sufficiency. None of them, however, at any time ate enough protein, which was generally from 35 to 40 percent below standard. *Low ration.* Five cows ate this ration. Three ate an insufficient amount of nutrients, one almost enough, and Elsa quite enough. As was the case with the very low ration, however, protein was always lacking in quantity. *Medium ration.* Four cows ate this ration. Three ate more than was needed to meet standard requirements, and one just about enough.

Wolff-Lehmann. The high total dry matter requirement was met only when the medium rations were fed and sometimes not then.[1] *Very low ration.* Half the cows ate enough total digestible nutrients and digestible carbohydrates, and half did not. Only two ate enough protein. *Low ration.* Two ate enough and three an insufficiency to meet standard requirements. *Medium ration.* Plenty and to spare were eaten by all the cows of every nutrient.

[1] The Wolff-Lehmann total dry matter standard for fresh cows is extremely high, too high for the generality of American cows and American fodders, feeds and rations.

RESULTS

For convenience of discussion the results of the two methods of experimentation—by alternate periods and by continuous feeding combined with alternation—are considered together on page 226. The results will be contrasted in another article further on in this report which has to do with the comparative merit of the two methods as means of arriving at truth.

As has been already remarked, the data of these feeding trials, although greatly condensed, are, notwithstanding, voluminous. As few figures as possible are given in the text. It is thought, however, that the scheme of tabulation and the true meaning of the figures are made clear by the captions of the tables and by the note at the bottom of the next page.

The tables on page 226 show the results by the alternation method. They also show the effects of continuous feeding. They are summarized from tables VI (*b*) and VII at various points in the appendix and show the increase or decrease—expressed in percentages, total equaling 100—in the dry matter eaten, in the milk, total solids and fat yielded, and in the products to 100 pounds of dry matter eaten when:

Table 1. Hay, silage and 4 pounds of grain were fed instead of hay, silage and 2 pounds of grain, or vice versa(*low and very low grain feeding*).

Table 2. Hay, silage and 8 pounds of grain were fed instead of hay, silage and 2 pounds of grain, or vice versa (*medium and very low grain feeding*).

Table 3. Hay, silage and either 2, 4 or 8 pounds of grain fed in comparison with the same.

Table 3 shows the increase or decrease in consumption and production when no change whatever was made, when the very low or the low or the medium ration was fed continuously. This comparison is in a measure a check upon the work, since it shows what might be termed the experimental error—and its probable extent—incident to the method of feeding and to the scheme of calculation used. The comparatively even run of figures and their relatively low value add strength to the conclusions which may be drawn from the other data.

It should be noted that in tables 1 and 2 (*a*) indicates the percentage results obtained when the second named ration was substituted for the first, the former being always the richer ration; that (*b*) represents the outcome when the poorer ration was substituted for the better one; and that (*c*) shows the percentage gain or loss sustained from 23 to 138 days' feeding on the richer as compared with the poorer

ration. These three comparisons were obtained with the same cows in the same series of tests. They are arrived at, however, in three different ways, yet they all tell much the same story.

The different rations had the following nutritive ratios:

	Very low feeding		Low feeding		Medium feeding	
	Range	Average	Range	Average	Range	Average
No. 2..................	1:7.3—1:8.3	1:7.9	1:6.2—1:7.3	1:6.6	1:4.9—1:5.8	1:5.3
No. 3..................	1:7.1—1:7.7	1:7.4	1:5.7—1:6.6	1:6.3	1:5.5—1:5.8	1:5.7

NOTE.—The tables on page 226 and several others in sections of this article numbered III *and seq.* are so very highly condensed that, unless further explained, they are likely to prove unintelligible. In the first place the reader is directed to the three pages of text at the end of the appendix, explanatory of the so-called "difference tables." The nature of these tables—which aim to measure the relative feeding values of the sundry rations—and of the summaries given in the text of this article is shown therein at length.

The tables 1 to 3 given herewith, as well as the several following printed in the discussion, show the *increase or decrease, as the case may be, in the amounts of dry matter eaten, of milk, solids and fat yielded, and of production proportioned to 100 pounds of dry matter, when one ration replaced another.* These increases and decreases are expressed as *percentages* of the total, total equalling 100. Thus for example the cows fed low and very low rations for 138 days on each (fifth line table) ate 2802 pounds of dry matter when getting the low and 2614 pounds of dry matter when fed the very low ration. They ate 188 pounds less dry matter (2802—2614) on the latter ration than on the former. This is a decrease of 7 percent (188÷2802=0.07) over the feeding on the low ration. This figure, —7, a decrease of 7 percent in dry matter, appears in the appropriate column in the fifth line of table 1, immediately to the right of the figure 133. It shows that when a change was made from a low to a very low grain ration 7 percent less dry matter was eaten as a result of that change than was consumed on the better feed. In other words —7 is in this case the "percentage of decrease," "total (2802) equalling 100." All the other figures, be they + or —, increases or decreases, in these and the similar tables further along in this article, were thus derived and have a similar significance.

SUMMARY OF DIFFERENCE TABLES, ETC., (APPENDIX VI (*b*) AND VII)

RATIONS (*a*) When changed from the lower to the higher ration (*b*) When changed from the higher to the lower ration (*c*) When changed from the higher to the lower ration	Periods represented or days of feeding	Total dry matter eaten	Quantity of milk	Total solids, percent	Fat, percent	Quantity of total solids	Quantity of fat	Products per 100 pounds of dry matter: Milk	Total solids	Fat	Ratio of fat to solids-not-fat
TABLE 1. LOW AND VERY LOW GRAIN FEEDING											
(*a*) Very low to low*	3	+6	+11	+1	+2	+12	+13	+4	+6	+6	
(*a*) Very low to low†	1	+10	+8	+3	+7	+12	+16	−2	+1	+6	
(*b*) Low to very low*	3	−8	−6	0	−2	−6	−8	+2	+2	+1	
(*b*) Low to very low†	1	−13	−8	0	−3	−8	−11	+6	+6	+2	
(*c*) Low to very low*	138	−7	−8	−1	−2	−8	−9	−1	−2	−3	+1
(*c*) Low to very low†	46	−11	−7	−2	−5	−9	−12	+3	+2	+1	+4
TABLE 2. MEDIUM AND VERY LOW GRAIN FEEDING											
(*a*) Very low to medium*	3	+25	+16	+3	+4	+19	+21	−7	−4	−3	
(*b*) Medium to very low*	3	−23	−16	−2	−4	−18	−20	+8	+5	+4	
(*b*) Medium to very low†	1	−22	−13	−2	−5	−15	−17	+11	+8	+6	
(*c*) Medium to very low*	138	−21	−15	−3	−4	−17	−18	+8	+5	+4	+2
TABLE 3. UNCHANGED GRAIN FEEDING											
Very low to very low*	3	−1	+2	0	−1	+2	+1	+3	+2	+2	
Very low to very low†	2	−3	0	0	−2	+1	−2	+4	+3	+2	
Very low to very low*	69	−3	−4	0	−2	−4	−6	−1	−2	−4	+2
Very low to very low†	46	0	−1	+1	+1	0	0	−1	0	+1	−1
Low to low*	3	−1	+9	0	0	+8	+8	+9	+8	+8	
Low to low*	69	−1	+2	0	0	+1	+2	+2	+2	+2	−1
Medium to medium*	3	+1	−1	+1	+1	+1	+1	−1	0	0	
Medium to medium*	69	−1	+1	0	+2	0	−1	+1	+1	0	+3

The next set of tables shows the outcome by the other method of experimentation, wherein a combination is used of the continuous and the alternating systems. A full discussion of this method with the condensed data on which the table is based is found in the article entitled "A Comparison of Feeding Trial Methods" further on in this volume.

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* Mixed feed No. 2 used.

† Mixed feed No. 3 used.

CHANGES IN PRODUCTION, EXPRESSED AS PERCENTAGES, RESULTING FROM CHANGING RATIONS

Nature of change in ration	Number of comparisons	Total dry matter eaten	Quantity of milk	Total solids, percent	Fat, percent	Quantity of total solids	Quantity of fat	Products per 100 pounds of dry matter		
								Milk	Total solids	Fat
Very low to low..........	3	+ 7	+ 9	+1	+3	+10	+12	+ 2	+3	+5
Very low to low..........	1	+12	+ 9	+2	+7	+12	+17	− 4	−1	+4
Low to very low..........	2	− 7	−12	−1	−3	−12	−11	− 5	−5	−6
Very low to medium....	3	+26	+14	+3	+5	+17	+20	−10	−7	−5
Medium to very low.....	3	−22	−17	−3	−5	−19	−21	+ 8	+6	+4

RESUMÉ

The strict verbalized summary to be made from table 1,—which is typical of that which might be drawn from table 2, and from several others following in this article—may be stated as follows:

1. Seven percent more dry matter eaten from the low rations than was eaten of the very low rations produced 10 percent more milk, 12 percent more total solids and 14 percent more fat. There was, however, a saving of from 3 to 6 percent of dry matter.

2. Ten percent less dry matter fed in the very low rations than was consumed when the low rations were given, made 7 percent less milk, 7 percent less solids and 9 percent less fat, at a saving of from 2 to 3 percent of dry matter. (*b*)

3. Nine percent less dry matter fed in the very low rations than was eaten in the same time on the low feed, made 8 percent less milk and solids and 9 percent less fat, saving at the same time a percent or two of dry matter. (*c*)

This statement is exact and categorical. It is the direct interpretation of the tabulated data into text. But its meaning is hard to grasp, and the real, practical outcome is not shown. It seems the wiser course, therefore, to make the verbal conclusions less exact but not less correct as generalizations. This course will be taken with all the tabulations of this character throughout this article.

The outcome as regards production and economy of production in this series of trials—as judged by both methods of measurement, the alternating and the combined,—may be stated in the following inferences:

1. *Adding grain to a very low grain ration.*—When 2 pounds of grain were added to a ration of hay, silage and 2 pounds of grain (making 4 pounds of grain in all) there were made 9 percent more milk and from 12 to 15 percent more total solids and fat. The quality of the milk seemed somewhat improved. The increase in dry matter eaten was 8 percent; yet the gain overbalanced this increase. Hence 100 pounds of dry matter made from 2 to 5 percent more product on the low than it did on the very low ration.

2. *Dropping grain from an already low grain ration.*—Dropping 2 pounds of grain from a ration of hay, silage and 4 pounds of grain resulted in from 7 to 12 percent lessened production. The quality of the flow was somewhat deteriorated as a result of the lessened food. There was 9 percent less total dry matter eaten; hence a unit of dry matter made about as much milk, total solids and fat on the poorer as were made on the better ration.

3. *Adding a considerable amount of grain to a very low grain ration.*—When 6 pounds of grain were added to a ration of hay, silage and 2 pounds of grain (making 8 pounds of grain in all) from 15 to 20 percent increase in milk, solids and fat was obtained. The milk improved in quality. Twenty-five percent more dry matter was eaten; hence a pound of dry matter made from 4 to 9 percent less product on the higher ration.

4. *Dropping a large proportion of the grain from a medium grain ration.*—When 6 pounds of grain were dropped from a ration of hay, silage and 8 pounds of grain, production was lessened from 15 to 20 percent. The quality of the milk was considerably lowered as a result of the changed ration. There was 22 percent less dry matter fed and the producing power of a unit of dry matter was raised from 4 to 8 percent.

5. *Uniform feeding.*—Eight comparisons of uniform feeding covering 11 period comparisons and 253 days' feeding on each side of the equation are at hand and may be summarized as follows:

When the rations were fed at diverse times, and when, by calculation, the effects of advancing lactation had been neutralized, so far as might be, the results arrived at by comparing calculated and actual yields were found to be closely alike.[1]

The outcome of these trials summarized from the standpoint of product rather than of feeding may be stated as follows:

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[1] Omitting the fifth line in table 3, page 226, which, owing to Flora's great shrinkage in her fifth feeding period, is thrown very much awry.

1. *Quantity.*—The more grain, the more milk, total solids and fat. The gains averaged 10 percent when the 4 pound ration replaced the 2 pound feed, and about 18 percent when the 8 pound was used in lieu of the 2 pound ration.

2. *Quality.*—There were twenty-two changes from one ration to another in these trials. In eighteen of these the alterations in the quality of the milk were found to be in the same direction as those in the feeding, bettering with an increased ration and lowering when grain was withdrawn. In three of the four remaining cases no change occurred. Very low grain feeding affected the fat content of the milk perceptibly and to its detriment, the diminution averaging 0.25 percent total solids and 0.20 percent fat, which would be equivalent to 2 and 4 percents respectively of the entire contents.

It would seem as if in these trials a slight lowering of the quality of the milk, if not caused by, at least accompanied the use of a very low grain ration.

3. *Economy of production.*—A pound of dry matter went further and made more milk, solids and fat on the very low ration than on the medium. As between the low and the very low rations the outcome was nearly equal. Sometimes one and sometimes the other did the better as regards economy of production.

4. *Live weight.*—About two-thirds of the cows responded to radical changes in the amount of grain fed by gaining flesh or losing it, according as feed was added or withdrawn. Those uniformly fed as a rule held their own, save Atalanta, uniformly fed the 2 pound ration, who lost a hundred pounds. A typical dairy cow, she poured her own flesh into the milk pail.

The outcome may be graphically illustrated as follows:

	Very low to low	Low to very low	Very low to medium	Medium to very low	Uniform feeding
Quantity	+	—	+	—	0
Quality	+	—	+	—	0
Economy of production	?	?	—	+	0

FINANCIAL CONSIDERATIONS

The discussion thus far has been directed to a consideration of the effect of varying grain rations on production and on the economy of production. A more direct study of the financial side of the operation is now in order. *Does it pay to feed cows as much as 8 or as little as 2 pounds of grain daily?*

The tables on the next four pages show:

1. The weights of the various fodders and feeds eaten.
2. The weights of milk and butter produced.
3. The money value[1] of the food eaten.
4. The cost of food for 100 pounds of milk and for 1 pound of butter.
5. Proceeds from butter sales at 20 cents a pound.[2]
6. The fertilizing value[3] of the rations.
7. The total value of all production (butter, skim milk[4] and two-thirds of fertilizing ingredients.)
8. Gain, net gain or loss, and daily net gain or loss when one ration is compared with another.

These are shown for the experimental portions of the periods only. Lactation changes are exactly equalled by calculation; hence each ration has the same chance as its rival to prove its worth.

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[1] Hay $10, silage $3, bran $17.50, cottonseed meal $29, linseed meal $32, dried brewers' grains $19, dried distillers' grains $28, Nutrene $23. corn meal $26. These are the average market prices for grain feeds (in the winter of 1902-1903) and average estimates of several prominent and successful farmers in various portions of the State of the money values of hay and silage at the barn ready for feeding.

It should be noted in this connection that the prices used for roughage are relatively high, considerably larger than those often used in calculations of this character. It is also to be observed that the prices for grain are higher than in the west, and higher than have ruled prior to the year 1900. It is well understood that grain has sold at high figures during the past few winters. These factors serve to increase calculated costs and to decrease or, perhaps, obliterate profits. As the comparisons have only relative values, however, this is not a serious matter. It is referred to in order to forestall possible criticism as to the high cost for food of making a pound of butter. It would be easy to "figure" much cheaper milk and butter.

[2] This is not the price the Station gets for its butter but simply a statement of average butter values of late years. It is a low price as winter creamery butter has recently sold.

[3] Nitrogen 17 cents, phosphoric acid 4 cents, potash 4¼ cents; 1903 trade values for the same ingredients of essentially similar availability in commercial fertilizers.

It is uncertain how much of the plant food may reach the soil. This depends on many factors. It is conservative to estimate two-thirds as ultimately available.

[4] Allowing 20 cents a hundred for skimmilk, its feeding value in our more recent experiments. This is a low price in view of the present high prices for pork.

COMPARATIVE VALUES OF VARIOUS RATIONS FROM THE FINANCIAL STANDPOINT

RATIONS	Hay	Silage	Wheat bran	Dried brewers' grains	Dried distillers' grains	Milk	Butter	Money value of food	Cost of food for 100 lbs. of milk	Cost of food for 1 lb. butter	Proceeds from butter at 20 cents	Fertilizing value of food eaten
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	$	cts.	cts.	$	$
138 DAYS ON VERY LOW RATION VS. 138 DAYS ON LOW RATION (NO. 2, DRIED BREWERS' GRAINS AND BRAN)												
Very low	1827	3669	90	181	7	2135	124.5	17.26	80.9	13.9	24.90	11.24
Low	1778	3671	182	353	11	2318	137.3	19.49	84.0	14.2	27.46	12.95
Differences in favor of medium ration						+ 183	+12.8	+2.23	+ 3.1	+ 0.3	+2.56	+1.71
Percentage differences						+ 9	+ 10	+ 12	+ 4	+ 2	+ 10	+ 15

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; very low ration $36.05, low ration $40.06.

Difference in favor of low ration, $4.01.

Gain ($4.01), less extra cost ($2.23), gives net gain $1.78, daily net gain 1.29 cents.

46 DAYS ON VERY LOW RATION VS. 46 DAYS ON LOW RATION (NO. 3, DRIED DISTILLERS' GRAINS)

Very low	474	1051	30		61	745	43.6	5.06	67.9	11.6	8.72	3.23
Low	471	1052	60		120	805	49.5	6.15	76.4	12.4	9.90	3.94
Differences in favor of medium ration						+ 60	+ 5.9	+1.09	+ 8.5	+ 0.8	+1.18	+0.71
Percentage differences						+ 8	+ 14	+ 22	+ 13	+ 7	+ 14	+ 22

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; very low ration $12.14, low ration $13.91.

Difference in favor of low ration $1.77.

Gain ($1.77), less extra cost ($1.09), gives net gain $0.68, daily net gain 1.48 cents.

184 DAYS ON VERY LOW RATIONS VS. 184 DAYS ON LOW RATIONS (NOS. 2 AND 3, BOTH RATIONS)

Very low	2301	4720	120	181	68	2880	1681	22.31	77.5	13.3	33.62	14 46
Low	2249	4723	242	353	131	3123	1868	25.63	82.1	13.7	37.36	16.87
Differences in favor of medium rations						+ 243	+ 187	+3.32	+ 4.6	+ 0.4	+3.74	+2.41
Percentage differences						+ 8	+ 11	+ 15	+ 6	+ 3	+ 11	+ 17

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; very low ration $48.18, low ration $53.95.

Difference in favor of low ration, $5.77.

Gain ($5.77), less extra cost ($3.32), gives net gain $2.45, daily net gain 1.33 cents.

COMPARATIVE VALUES OF VARIOUS RATIONS FROM THE FINANCIAL STANDPOINT

RATIONS	Hay	Silage	Wheat bran	Dried brewers' grains	Dried distillers' grains	Milk	Butter	Money value of food	Cost of food for 100 lbs. of milk	Cost of food for 1 lb. butter	Proceeds from butter at 20 cents	Fertilizing value of food eaten
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	$	cts.	cts.	$	$
138 DAYS ON VERY LOW RATION VS. 138 DAYS ON MEDIUM RATION (NO. 2, DRIED BREWERS' GRAINS AND BRAN)												
Very low	1542	3691	90	180	7	1973	120.6	15.85	79.0	13.1	24.12	10.27
Medium	1498	3599	359	698	23	2321	147.8	22.93	98.8	15.5	29.56	15.65
Differences in favor of medium ration						+ 348	+ 272	+7.08	+19.8	+ 2.4	+5.44	+5.38
Percentage differences						+ 18	+ 23	+ 45	+ 25	+ 18	+ 23	+ 52

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; very low ration $34.34, medium ration $43.96.

Difference in favor of medium ration, $9.62.

Gain ($9.62), less extra cost ($7.08), gives net gain $2.54, daily net gain 1.84 cents.

RATIONS	Hay	Silage	Wheat bran	Dried brewers' grains	Dried distillers' grains	Milk	Butter	Money value of food	Cost of food for 100 lbs. of milk	Cost of food for 1 lb. butter	Proceeds from butter at 20 cents	Fertilizing value of food eaten
23 DAYS ON VERY LOW RATION VS. 23 DAYS ON MEDIUM RATION (NO. 3, DRIED DISTILLERS' GRAINS AND BRAN)												
Very low	265	690	15		31	465	23.7	2.93	63.1	12.4	4.74	1.85
Medium	250	683	54		107	535	28.6	4.24	79.3	14.8	5.72	2.73
Differences in favor of medium ration						+ 70	+ 4.9	+1.31	+16.2	+ 2.4	+0.98	+0.88
Percentage differences						+ 15	+ 21	+ 45	+ 26	+ 19	+ 21	+ 48

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; very low ration $6.77, medium ration $8.45.

Difference in favor of medium ration, $1.68.

Gain ($1.68), less extra cost ($1.31), gives net gain $0.37, daily net gain 1.61 cents.

RATIONS	Hay	Silage	Wheat bran	Dried brewers' grains	Dried distillers' grains	Milk	Butter	Money value of food	Cost of food for 100 lbs. of milk	Cost of food for 1 lb. butter	Proceeds from butter at 20 cents	Fertilizing value of food eaten
161 DAYS ON VERY LOW RATIONS VS. 161 DAYS ON MEDIUM RATIONS (NOS. 2 AND 3 BOTH RATIONS)												
Very low	1807	4381	105	180	38	2438	144.3	18.77	77.0	13.1	28.86	12.12
Medium	1748	4282	413	698	130	2856	176.4	27.17	95.1	15.4	35.28	18.38
Differences in favor of medium rations						+ 418	+32.1	+8.40	+18.1	+ 2.3	+6.42	+6.26
Percentage differences						+ 17	+ 22	+ 45	+ 24	+ 18	+ 22	+ 52

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; very low ration $41.11, medium ration $52.41.

Difference in favor of medium ration, $11.30.

Gain ($11.30), less extra cost ($8.40), gives net gain $2.90, daily net gain 1.80 cents.

COMPARATIVE VALUES OF VARIOUS RATIONS FROM THE FINANCIAL STANDPOINT

RATIONS	Hay	Silage	Wheat bran	Dried brewers' grains	Dried distillers' grains	Milk	Butter	Money value of food	Cost of food for 100 lbs. of milk	Cost of food for 1 lb. butter	Proceeds from butter at 20 cents	Fertilizing value of food eaten
	lbs.	lbs.	lbs	lbs.	lbs.	lbs.	lbs.	$	cts.	cts.	$	$
69 DAYS ON VERY LOW RATION VS. 69 DAYS ON VERY LOW RATION (NO. 2, DRIED BREWERS' GRAINS AND BRAN)												
Very low (1)......	759	2066	45		7	1299	54.7	8.24	68.4	15.0	10.94	5.27
Very low (2)......	753	2068	45	92		1249	51.5	8.12	65.0	15.8	10.30	5.22
Differences in favor of ration 1						− 50	− 3.2	−0.12	+ 1.6	+ 0.8	−0.64	−0.05
Percentage differences..........						− 4	− 6	− 1	+ 3	+ 5	− 6	− 1
46 DAYS ON VERY LOW RATION VS. 46 DAYS ON VERY LOW RATION (NO. 3, DRIED DISTILLERS' GRAINS AND BRAN)												
Very low (1)......	511	1378	30		62	610	35.7	5.76	94.4	16.1	7.14	3.63
Very low (2)......	515	1380	30		62	605	35.8	5.78	95.5	16.1	7.16	3.65
Differences in favor of ration 2.						− 5	+ 0.1	+0.02	+ 1.1	0	+0.02	+0.02
Percentage differences..........						− 1	0	0	+ 1	0	0	+ 1
69 DAYS ON LOW RATION VS. 69 DAYS ON LOW RATION (NO. 2, DRIED BREWERS' GRAINS AND BRAN)												
Very low (1)......	751	1656	93	174	11	1147	63.2	88.6	77.3	14.0	12.64	5.89
Very low (2)......	765	1658	93	183		1165	64.2	88.6	76.2	13.8	12.84	5.90
Differences in favor of ration 2.						+ 18	+ 1.0	0	− 1.1	− 0.2	+0.20	+0.01
Percentage differences..........						+ 2	+ 2	0	− 1	− 1	+ 2	0

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; very low ration (1) $16.68, very low ration (2) $15.92.

Difference in favor of (1) ration, $0.76.

Gain ($0.76), less extra cost ($0.12), gives net gain $0.64, daily net gain 0.93 cents.

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; very low ration (1) $10.60, very low ration (2) $10.62.

Difference in favor of (2) ration, $0.02.

Gain ($0.02), less extra cost ($0.02), gives net gain 0. daily net gain 0.

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; low ration (1) $18.53, low ration (2) $18.76.

Difference in favor of (2) ration, $0.23.

Gain ($0.23), less extra cost (0), gives net gain $0.23. daily net gain 0.50 cents.

COMPARATIVE VALUES OF VARIOUS RATIONS FROM THE FINANCIAL STANDPOINT

RATIONS	Hay	Silage	Wheat bran	Dried brewers' grains	Dried distillers' grains	Milk	Butter	Money value of food	Cost of food for 100 lbs. of milk	Cost of food for 1 lb. butter	Proceeds from butter at 20 cents	Fertilizing value of food eaten
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	$	cts.	cts.	$	$
69 DAYS ON MEDIUM RATION VS. 69 DAYS ON MEDIUM RATION (NO. 2, DRIED BREWERS' GRAINS AND BRAN)												
Medium (1).......	769	1647	181	343	28	1143	76.5	11.49	100.5	15.0	15.30	7.85
Medium (2).......	767	1656	183	369		1150	75.6	11.44	99.5	15.1	15.12	7.85
Differences in favor of ration 1						+ 7	− 0.9	−0.05	− 1.0	+ 0.1	−0.18	0
Percentage differences..........						+ 1	− 1	0	− 1	+ 1	− 1	0

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; medium (1) ration $22.48, medium (2) ration $22.31.

Difference in favor of medium (1) ration, $0.17.

Gain ($0.17), less extra cost ($0.05), gives net gain $0.12, daily net gain 0.17 cents.

The following deductions seem warranted by the data in the foregoing tables:[1]

1. *Very low and low grain feeding.*—When the two rations used in this experiment were fed with hay and silage at the rate of 4 pounds instead of 2 pounds daily, from 8 to 9 percent more milk was made, and 11 percent more butter. The cost of feed for making this extra product was found to be 15 percent greater on the better ration. It cost on the average 6 percent more to make a pound of milk and 3 percent more to make a unit of butter on the 4 pound than on the 2 pound ration. There was of course more skimmilk made on the former ration, and it contained on the average 17 percent more fertilizing ingredients. When these two items are reckoned in, the better ration

[1] Neither in this comparison nor in those of a similar nature following in this article are the costs of the manufacture of the product, of marketing it, of caring for the cows, etc., considered. They would be essentially the same on both sides, and to admit them would obscure the only important point, namely, the comparison of the feeding values of the rations. The figures arrived at have no absolute values, but are serviceable solely for comparative purposes.

leads; if the increase of butter only is considered, it still leads, but by the very narrow margin of less than one-quarter of a cent per cow for one day's feeding. Using average figures only, the daily feeding of the 2 pounds extra grain for 184 days entailed an extra cost of $3.32, and an added butter yield worth $3.74, a gain of 42 cents. It also made 200 pounds more skimmilk and better manure. If the former be reckoned at 20 cents and two-thirds of the latter is reckoned at the prices stated in the footnote on page 230, there is a gain of $5.77 as an offset against the $3.32 extra cost, a net gain of $2.45, or a daily net gain of 1.33 cents for each cow, as a result of feeding 4 pounds of grain daily instead of 2 pounds.

2. *Very low and medium grain feeding.*—When the two rations used in these feeding trials were fed with hay and silage at the rate of 8 pounds daily instead of 2 pounds daily, there was made from 15 to 18 percent more milk and from 21 to 23 percent more butter on the richer ration. The better ration cost, however, 45 percent more than did its competitor. It cost 24 percent more to make a quart of milk and 18 percent more to make a pound of butter on the 8 pound than on the 2 pound ration. The extra skimmilk and manurial values enter into the problem as before. If they are not included there is some loss from the use of the heartier ration. When these are allowed for, however, the better ration comes out well ahead. The daily feeding of the 6 pounds extra grain for 161 days cost $8.40 more; but it made $6.42 worth more butter, while the increase in skimmilk and in manurial value, reckoned as before, are calculated at $4.88. The net gain then is $2.90, and the daily net gain for each cow is 1.80 cents, as a result of feeding 8 pounds of grain daily instead of 2 pounds.

The salient points of the tables on pages 231-234, and of the discussion appear on the following page. The table shows the days of feeding on each ration, the added cost for feed of the higher grade ration, the net gain from butter sales, the net loss when these alone are considered as an asset. the value of the skimmilk and of two-thirds of the manurial ingredients, the net gain from butter, skimmilk and manure and the net gain or loss from feeding one cow for one day.

RELATIVE VALUE OF VERY LOW, LOW, AND MEDIUM FEEDING

	Low better than very low	Medium better than very low
Days of feeding on each ration	184	161
Cost of added grain feed	$3.32	$8.40
Net gain from butter sales @ 20 cents	$3.74	$6.42
Net gain or loss, i. e. cost of additional grain less value of butter	$0.42	—$1.98
Value of skimmilk and of two-third of the manurial ingredients	$2.03	$4.88
Net gain from butter, skimmilk and manure	$2.45	$2.90
Net gain from one day's feeding of one cow	1.33 cents	1.80 cents

3. *Uniform feeding.*—In three cases out of four when unchanged rations were fed the results, as might have been expected, were fairly uniform. The amounts of milk and butter made, the money values of the food eaten and the costs of food for making milk and butter varied but little, two percent being the highest figure. Yet when these relatively small differences are translated into terms of dollars and cents some differences occur. In one case—the first—Atalanta's record shows discrepancies, caused solely by her relatively large milk yield during the third period. It is an abnormality, such as will occasionally be found when the records of single cows are handled.

4. *Does it pay to feed as little as 2 pounds of grain daily?*—In considering this matter let us at first exclude all the items except lessened cost for grain and lessened butter yield.

When 2 pounds of grain were fed instead of 4, $3.32 were saved on grain bills and $3.74 lost in butter not made because of the parsimonious grain feeding.

When 2 pounds of grain were fed instead of 8, $8.40 were saved on grain bills and $6.42 lost in butter not made because of the stinted grain ration.

The extra cost of grain was more than paid for in increased income from butter, when the grain ration was doubled. Only three-fourths of its extra cost was met thus, however, when the grain ration was quadrupled.

Since a 4 pound grain ration paid better than a 2 pound one when the butter increase alone is considered, so much the better does it appear when skimmilk and manurial constituents are taken into account. Since the 8 pound ration came within $2.00 of meeting extra grain bills by extra butter yield, and its skimmilk and manurial values exceeded those of the very low ration by nearly $5.00, the heavier ration may justly be counted the more satisfactory.

No one could see Atalanta, before and after taking, in good flesh December 5, but lean and gaunt May 27 after twenty-five weeks of feeding on 2 pounds daily of grain, hay and immature silage; or view the sharp falls in milk yields which almost invariably followed the curtailment in the grain rations, or the partial increase which paralleled their restoral, without becoming convinced of the relationship between grain and milk. And the figures, which in this case maintain their proverbial honesty, tell the story of lessened profit.

The bulk of the records were attained with bran and brewers' grains, each selling below $20. When the distillers' grains, selling at $28, were used, less positive results were attained but they were in the same direction. Their number, however, were small because of reasons hitherto cited.

It seems fair to conclude that in these trials the restriction of the grain ration to 2 pounds was made at the expense of the animals' well-being and of the owner's pocket-book.

As to the relative merits of 4 and 8 pound grain rations, and the "best" grain ration as to quality and quantity the reader is referred to the last (15th) report, pages 299-300, and to bulletin 81.

Further work as to the merits of the 2 pound ration is planned for next year, when it is hoped mature silage may be fed. Under these conditions a restricted ration will have a better chance for success.

IV. DISTILLERS' DRIED GRAINS, CLEAR AND DILUTED WITH BRAN

The distillers' dried grains have been fed at the Station in years past with much satisfaction.[1] The particular brand used was known as "Atlas gluten meal." It was not true to name and was in no sense whatsoever a gluten meal. The high value of this particular brand was well brought out in these trials.

About a year ago, however, several new brands of distillers' dried grains were offered in Vermont under their proper titles. They differed somewhat physically, though but little chemically, from the "Atlas" goods. They were new here and quite unlike anything hitherto offered. Inquiries began to come in as to their feeding values, also as to the amounts that it was safe to feed. There seemed to be room for further trials of these materials and several were planned.

In one trial the clear undiluted grains were fed against a mixture of two-thirds grains and one-third bran; in another, against brewers'

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[1] Vt. Sta. Rpts., 9, pp. 220-223 (1895); 10, pp. 146-164 (1896); 11, pp. 320-336 (1897).

dried grains, and in a third against the old time cottonseed-linseed mixture (No. 1).

These grains are the by-product of the manufacture of alcohol, spirits and whiskey from several cereals. They are simply the kiln-dried residues from the stills. They contain no alcohol, but, because of the fermentation which they have undergone, they have a peculiar and characteristic odor, which, however, is not at all disagreeable. There are quite generally three grades made, one from the distillation of alcohol and spirits, a second from the distillation of bourbon whiskey, and a third from that of rye whiskey. The first named is the higher in feeding value, and is most apt to be of even quality, corn being the main, and, sometimes, the only grain used. The other grades vary in their composition in proportion to the relative proportion of corn, rye and malt used in the mashes; the more the corn and the less the smaller grains, the better the grade of the product. The higher grades only have thus far been found upon the Vermont markets, mostly guaranteed from 33 to 35 percent protein and 11 to 15 percent fat.

The Commissioner of internal revenue states that over twenty-three million bushels of grain—mostly corn—were used in the United States distilleries for the year ending June 30, 1900. The present annual output of distillers' dried grains exceed 40,000 tons, the larger share being exported to Germany for cattle feeding.

In this particular feeding trial the effect of heavy feeding was reviewed, inasmuch as sellers were stating that, owing to their flaky character, the goods did not need dilution with bran and might be fed clear with safety and with profit.

FEEDING

Four cows, three fresh and one six months in milk, were chosen for this test. Three were fed in alternation 8 pound grain rations, two-thirds distillers' dried grain and one-third bran, and clear undiluted dried grains. The fourth ate clear, undiluted grains for 175 consecutive days, leaving some, however, so that her average consumption was 7 pounds instead of 8 pounds.

COMPARISON WITH STANDARDS

Wolff.—The cows ate considerably in excess of standard needs, particularly of protein, save in the case of one period with one cow.

Wolff-Lehmann.—Same as with Wolff standard save that total dry matter standards at times were not met.

The following table summarized from various points in the appendix shows the increase or decrease—expressed as percentages, total equalling 100—in dry matter eaten, milk, total solids, and fat given, and of products per 100 pounds of dry matter, both in the total and the grain rations, when a ration containing clear distillers' dried (No. 4) was substituted for one carrying two-thirds of these and one-third of wheat bran (No. 3)—nutritive ratios ranging from 1:4.7 to 1:5.4, averaging 1:5.1 in the first case and from 1:5.1 to 1:5.5 and averaging 1:5.3 in the second case; hay and silage as roughages being fed throughout.

SUMMARY OF DIFFERENCE TABLES, ETC. (APPENDIX VI (*b*) AND VII)

RATIONS	Total dry matter eaten	Dry matter eaten in concentrates	Quantity of milk	Total solids, percent	Fat, percent	Quantity of total solids	Quantity of fat	Products per 100 pounds of dry matter: In entire ration: Milk	Total solids	Fat	In experimental feed: Milk	Total solids	Fat	Ratio of fat to solids-not-fat
No. 3 to No. 4*	−3	+1	+3	+1	+2	+4	+5	+6	+7	+9	+3	+4	+5	
No. 4 to No. 3†	+7	+16	+5	0	0	+5	+6	−2	−2	−2	−10	−9	−9	
92 days on No. 4														
92 days on No. 3	−5	−10	−3	0	0	−3	−3	+3	+3	+3	+9	+9	+9	0

RESUMÉ

The first table on page 246 shows the financial outcome. The undiluted grains than on those diluted with bran.

2. No change in the quality of milk ensued.

3. The clear grains were not eaten as freely as when they were diluted with bran. More milk and butter to the unit of dry matter was therefore made when the clear grains were fed.

FINANCIAL CONSIDERATIONS

The first table on page 246 shows the financial outcome. The grains cost more than the bran, but when fed clear they were eaten

* This line of figures is quite out of accord with the other. It is based on a single record of the cow Serena, whose milk yield shrank seriously in the fifth period, bringing the average of the third and fifth below that of the fourth period. The feed which on the whole proved the least satisfactory was fed in the fourth period.

† Sonoma left large amounts of No. 4 uneaten in the fifth period, and consequently shrunk in yield. This episode accounts for the slight enlargement of some of the data.

with less readiness. Hence the cost of the two rations was essentially the same. They carried also almost identical plant food values. Differences, then, were purely those of milk and butter yields. The diluted rations made a profit of 80 cents over its competitor, and a net profit of 69 cents, equivalent to three-quarters of a cent a day, practically all in the form of butter.

Every cow left more or less when fed the undiluted dried grains, averaging to eat but 7 of the 8 pounds fed. When they were diluted with one-third bran they were eaten without waste three times out of four. Not only was there waste but also a lessened milk yield when the grains alone were fed. Hence it seems fair to say that the results afforded by this particular trial does not favor the exclusive use of distillers' dried grains as a concentrate.

V. BREWERS' AND DISTILLERS' DRIED GRAINS

The brewers' grains resemble in a general way the distillers' by-products. Like them they are kiln-dried residues from the manufacture of alcoholic beverages. They carry, however, less protein, more carbohydrates, presumedly more modified starch, are made from barley rather than from corn and, often, contain a considerable proportion of malt sprouts.

Dried brewers' grains have been on the market as recognized feeding stuffs for many years. They have been fed both wet and dry. Their proneness to fermentation and putrefaction when wet have caused some to look askance at them, even when they are dried. Indeed, a prominent writer of recent days, using a novelist's if not a poet's license, has helped to give this feeding stuff a bad name. When kiln-dried, however,—the feed, not the novelist,—it is thoroughly safe product, as stable as any other and preferable in many ways to several standard goods. It has been fed at this Station for two years with entire satisfaction. It has thus far entered the New England trade to but a small extent.

FEEDING

A comparative trial of the two grains was planned for the past winter and six cows used therein, four fairly fresh, and two eight to ten months in lactation. Three were fed in alternation and three were continuously fed one feed.

COMPARISON WITH STANDARDS

Wolff.—On the whole the feeding was a little—and only a little—short of standard requirements. This is particularly true of the two heavy cows far in lactation, making relatively little milk.

Wolff-Lehmann.—Too little total dry matter—as usual—but plenty and to spare of digestible dry matter and digestible nutrients characterize the eating of all the cows in the trial.

RESULTS

The following table, summarized from various points in the appendix, shows the increase or decrease—expressed in percentages, total equalling 100—in dry matter eaten, milk, total solids, and fat given, and of products per 100 pounds of dry matter, both in the total and the grain rations, when a ration containing dried brewers' grains and bran (No. 2) was substituted for one containing dried distillers' grains and bran (No. 3) or vice-versa—nutritive ratios varying from 1:5.0 to 1:5.9 and averaging 1:5.4 in the first case, and from 1:5.0 to 1:5.7 and averaging 1:5.3 in the second case; hay and silage as roughages being fed throughout.

SUMMARY OF DIFFERENCE TABLES, ETC. (APPENDIX VI (*b*) AND VII)

RATIONS	Total dry matter eaten	Dry matter eaten in concentrates	Quantity of milk	Total solids, percent	Fat, percent	Quantity of total solids	Quantity of fat	Products per 100 pounds dry matter: In entire ration: Milk	In entire ration: Total solids	In entire ration: Fat	In experimental feed: Milk	In experimental feed: Total solids	In experimental feed: Fat	Ratio of fat to solids-not-fat
No. 2 to No. 3	+ 2	− 2	+ 5	+ 1	+ 3	+ 6	+ 8	+ 4	+ 5	+ 7	+ 9	+ 9	+11	
No. 3 to No. 2	+ 2	+15	− 3	0	− 3	− 3	− 5	− 4	− 5	− 7	−16	−16	−17	
92 days on No. 3 ±92 days on No. 2	+ 1	− 5	+ 3	+ 1	+ 3	+ 6	+ 8	+ 4	+ 6	+ 8	+12	+12	+13	− 3

RESUMÉ

1. The distillers' grains made 5 percent more milk and 8 percent more butter than did the brewers' grains.

2. They made a somewhat richer milk, the gain being 0.14 percent fat or 3 percent of the total fat.

3. They were a little less freely eaten—5 percent less dry matter being consumed therein—than were the brewers' grains; but there was

more hay and silage eaten when the former was fed, so that the dry matter consumption was was closely evened up. Production per unit of matter, however, favored the distillers' products.

The increment in quality where distillers' grains were fed is interesting. It never failed to appear during the three years in which the so-called Atlas gluten meal (a distillers' grains) was fed at the Station, is noted here and is seen also in the competitive trials with the cottonseed-linseed mixture. There is something about distillers' dried grains which tends very slightly to raise the fat percentage of milk.

FINANCIAL CONSIDERATIONS

The outcome from the viewpoint of profit appears in the table on page 246. Brewers' grains were bought for $19, while the distillers' grains cost $28. This increase in cost was sufficient to turn the scales against the latter goods. Although their use was followed by increased milk and butter yields and by an added manurial value, equivalent, at the conventional figures, to $1.44, the ration cost $1.63 more than its competitor, thus entailing a net daily loss of a fifth of a cent per cow.

Hence the distillers' grains in this trial proved a better but more costly ingredient of the ration than did the brewers' grains. Both by-products, when kiln-dried, are desirable additions to the list of dairy feeds.

VI. DISTILLERS' DRIED GRAINS VS. COTTONSEED AND LINSEED MEALS

The mixture of two-thirds wheat bran, one-third cottonseed and one-third linseed meals, denominated No. 1, has been a standard of comparison at this Station for a long time. It is in many respects a good combination to feed with matûre corn silage and early cut hay. When corn ears are lacking in the silage a small amount of cornmeal is a desirable addition to the mixture; or it may take the place of the linseed, as in our No. 7 mixture for this year, when, because of the unfavorable growing season, corn ears were few. The No. 1 mixture has enough of that eminently desirable and safe milk-making feed, wheat bran, to serve as a dilutent of the heavier meals and to lighten the ration. The cottonseed and linseed meals supply liberal amounts of protein, and the one offsets the other's effect on the hardness of the butter fat. Its traditional number—No. 1—held for years, is a well merited one, although, in the various competitive trials of past years, it has sometimes come out second best.

A comparison was made this past winter of the relative merits of the old standby and of distillers' grains and bran mixed in the proportion of two to one. The two rations afforded nearly equal amounts of protein, but the latter rather more digestible dry matter, the increase being entirely in crude fiber and fat.

FEEDING

Six cows, two fresh, one two months, two five to six months, and one farrow were chosen.

Only two were fed in alternation, the others being continuously fed either one or the other ration. The unhappy mistake hitherto referred to very seriously curtailed the available data in this test, removing one cow's record entirely and damaging that of three others.

COMPARISON WITH STANDARDS

Wolff.—Three cows ate in excess of and three ate a close approximation to the standard ration.

Wolff-Lehmann.—As usual, too little total dry matter was eaten by five cows out of six. All six ate more digestible dry matter, more digestible protein, and as much or more digestible carbohydrates than the standard called for.

RESULTS

The following tables, summarized from those at various points in the appendix, shows the increase or decrease—expressed as percentages, total equalling 100—of dry matter eaten, of milk, total solids and fat given, and of the same per 100 pounds of dry matter eaten (as measured by the alternation and, also, by the combined alternation and continuity method) when a cottonseed-linseed ration (No. 1)—nutritive ratios ranging from 1:4.8 to 1:5.7 and averaging 1:5.2—replaced a distillers' grains ration (No. 3)—nutritive ratios ranging from 1:5.3 to 1:5.7 and averaging 1:5.5 or vice versa; hay and silage being fed as roughages throughout.

SUMMARY OF DIFFERENCE TABLES, ETC. (APPENDIX VI (*b*) AND VII)

RATIONS	Total dry matter eaten	Dry matter eaten in concentrates	Quantity of milk	Total solids, percent	Fat, percent	Quantity of total solids	Quantity of fat	Products per 100 pounds of dry matter: In entire ration: Milk	In entire ration: Total solids	In entire ration: Fat	In experimental feed: Milk	In experimental feed: Total solids	In experimental feed: Fat	Ratio of fat to solids-not-fat
No. 1 to No. 3	− 2	+ 1	− 1	+ 1	+ 4	+ 1	+ 3	0	+ 1	+ 4	− 2	− 1	+ 2	
No. 3 to No. 1	− 1	− 2	− 3	+ 1	0	− 2	− 3	− 2	− 2	− 2	− 1	+ 1	− 1	
69 days on No. 3+ 69 days on No. 1	0	+ 1	0	0	+ 2	+ 1	+ 3	0	+ 1	+ 3	− 1	0	− 3	− 1

RESUMÉ

1. There was no more milk made on one ration than on the other. One percent more solids and 3 percent more fat, however, were made on No. 3 than were made when its competitor was fed.

2. There was a small increase in the fat percentage when the distillers' grains were fed, similar to that seen in previous trials of this class of material, as noted on page 242.

3. Yields per unit of dry matter were practically uniform.

FINANCIAL CONSIDERATIONS

The distillers' grains ration made no more milk but nearly 3 pounds more butter than its competitor. The value of this extra 3 pounds more butter, however, was lost in the extra cost of the ration. The cottonseed-linseed ration carried 3 percent more plant food than did the distillers' grains ration; and hence led by the slight amount of 0.38 cents daily per cow. The results are tabulated on page 247.

VII. BREWERS' GRAINS VS. COTTONSEED AND LINSEED MEAL

The dried brewers' grains in feed mixture No. 2 were pitted against the No. 1 combination, using five cows.

FEEDING

Five cows, two fresh, two that had been in milk two to three months, and one nine months in milk, were fed three in alternation, two continuously.

COMPARISON WITH STANDARDS

Wolff.—One cow ate more than enough, one enough, one somewhat too little, and two considerably too little to meet standard requirements.

Wolff-Lehmann.—Two cows ate more than enough, one about enough and two too little to meet standard needs. None, however, met its high total dry matter requirement.

The following table, summarized from those at various points in the appendix, shows the increase or decrease—expressed as percentages, total equalling 100—of dry matter eaten, of milk, total solids and fat given, and of the same per 100 pounds of dry matter eaten (as measured by the alternation and, also, by the combined alternation and continuity method) when a cottonseed-linseed ration (No. 1)—nutritive ratios ranging from 1:4.7 to 1:5.1 and averaging 1:5.0—replaced a brewers' grains ration (No. 2)—nutritive ratios ranging from 1:5.0 to 1:5.9 and averaging 1:5.5 or vice versa; hay and silage being fed as roughages throughout.

SUMMARY OF DIFFERENCE TABLES, ETC. (APPENDIX VI (*b*) AND VII)

RATIONS	Total dry matter eaten	Dry matter in experimental feed	Quantity of milk	Total solids, percent	Fat, percent	Quantity of total solids	Quantity of fat	Products per 100 pounds of dry matter: In entire ration: Milk	In entire ration: Total solids	In entire ration: Fat	In experimental feed: Milk	In experimental feed: Total solids	In experimental feed: Fat	Ratio of fat to solids-not-fat
No. 1 to No. 2	− 3	− 3	− 1	0	+ 1	+ 1	0	+ 2	+ 2	+ 3	+ 1	+ 2	+ 2	
No. 2 to No. 1	+ 2	+ 2	+ 1	0	0	+ 1	+ 1	− 2	− 2	− 1	− 1	− 2	− 1	
188 days on No. 2± 188 days on No. 1	− 2	− 2	0	0	0	− 1	− 1	+ 2	+ 2	+ 1	+ 2	+ 2	+ 1	+ 1

RESUMÉ

1. The same amounts of milk, solids and fat were made on each ration.

2. No change in quality of milk followed ration changes.

3. The production per unit of dry matter eaten was the same with each ration.

A more even result could have been looked for had no change whatever occurred in the feeding.

FINANCIAL CONSIDERATIONS

The butter made when No. 1 ration was fed was worth 34 cents more than that made when No. 2 was used. No. 1 was the richer of the two in plant food; but it was the costlier one by over two dollars. Hence the net result was against it to the extent of 0.46 cents daily. The tabulated statement appears below.

RATIONS	Hay	Silage	Wheat bran	Dried distillers' grains	Dried brewers' grains	Milk	Butter	Money value of food	Cost of food for 100 lbs. of milk	Cost of food for 1 lb. butter	Proceeds from butter at 20 cents	Fertilizing value of food eaten
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	$	cts.	cts.	$	$
92 DAYS ON NO. 3 (DRIED DISTILLERS' GRAINS AND BRAN) VS. 92 DAYS ON NO. 4 (DRIED DISTILLERS' GRAINS) RATION												
No. 3	1051	2199	240	477		1864	103.8	17.34	93.2	16.7	20.76	11.21
No. 4	1001	2196		638		1807	100.8	17.23	95.4	17.1	20.16	11.05
Differences in favor of No. (3) ration						—57	—3.0	—0.11	+2.2	+0.4	—0.60	—0.16
Percentage differences						— 3	— 3	— 1	+ 2	+ 2	— 3	— 1

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; No. 3 ration $31.42, No. 4 ration $30.62.

Difference in favor of No. 3 ration, $0.80.

Gain ($0.80), less extra cost ($0.11), gives net gain $0.69, daily net gain 0.75 cents.

69 DAYS ON NO. 4 RATION VS. 69 DAYS ON NO. 4 (DRIED DISTILLERS' GRAINS) RATION

No. 4 (1)	763	1993		472		1549	82.7	13.42	86.6	16.2	16.54	8.55
No. 4 (2)	759	1953		497		1504	76.7	13.59	91.0	17.9	15.34	8.73
Differences in favor of No. (1) ration						—45	—6.0	+0.27	—14.4	+1.7	—1.29	+0.18
Percentage differences						— 3	— 7	+ 2	+ 5	+ 11	— 7	+ 2

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; No. 4 ration (1) $24.89, No. 4 ration (2) $23.73.

Difference in favor of (1) ration, $1.16.

Gain ($1.16), plus lessened cost ($0.27), gives net gain $1.43, daily net gain 2.07 cents.

92 DAYS ON NO. 2 (DRIED BREWERS' GRAINS AND BRAN) RATION VS. 92 DAYS ON NO. 3 (DRIED DISTILLERS' GRAINS AND BRAN) RATION

No. 2	971	2166	228		452	984	63.1	14.40	146.4	22.8	12.62	9.86
No. 3	1012	2156	211	421		1032	68.2	16.03	155.3	23.5	13.64	10.36
Differences in favor of No. (3) ration						+48	+5.1	+1.63	+ 8.9	+0.7	+1.02	+0.59
Percentage differences						+ 5	+ 8	+ 11	+ 6	+ 3	+ 8	+ 5

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; No. 2 ration $20.87, No. 3 ration $22.31.

Difference in favor of No. 3 ration, $1.44.

Gain ($1.44), less extra cost ($1.63), gives net loss $0.19, daily net loss 0.21 cents.

COMPARATIVE VALUES OF VARIOUS RATIONS FROM THE FINANCIAL STANDPOINT

RATIONS	Hay	Silage	Wheat bran	Dried distillers' grains	½ cottonseed meal ½ linseed meal	Milk	Butter	Money value of food	Cost of food for 100 lbs. of milk	Cost of food for 1 lb. butter	Proceeds from butter at 20 cents	Fertilizing value of food eaten
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	$	cts.	cts.	$	$
92 DAYS ON NO. 2 RATION VS. 92 DAYS ON NO. 2 RATION												
No. 2 (1)	925	2015	199	394	3	657	44.8	13.18	200.6	29.4	8.96	8.98
No. 2 (2)	922	1994	191	381		668	45.3	12.89	198.0	28.5	9.06	8.79
Difference in favor of No.(1) ration						+ 11	+ 0.5	− 2.9	− 7.6	− 0.9	+0.10	−0.19
Percentage differences						+ 2	+ 1	− 2	− 4	− 3	+ 1	− 2

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; (1) ration $16.07, (2) ration $16.06.

Difference in favor of (1) ration, $0.01.

Gain ($0.01), less extra cost ($0.29), gives net loss $0.28, daily net loss 0.30 cents.

RATIONS	Hay	Silage	Wheat bran	Dried distillers' grains	½ cottonseed meal ½ linseed meal	Milk	Butter	Money value of food	Cost of food for 100 lbs. of milk	Cost of food for 1 lb. butter	Proceeds from butter at 20 cents	Fertilizing value of food eaten
23 DAYS ON NO. 3 RATION VS. 23 DAYS ON NO. 3 RATION												
No. 3 (1)	211	505	61	121		334	18.3	4.04	121.0	22.1	3.76	2.60
No. 3 (2)	228	463	57	112		342	18.2	3.90	114.0	21.4	3.74	2.50
Differences in favor of No.(1) ration						+ 8	− 0.1	−0.14	− 7.0	− 0.7	−0.02	−0.07
Percentage differences						+ 2	− 1	− 3	− 6	− 3	− 1	− 3

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; (1) ration $6.06, (2) ration $6.02.

Difference in favor of (1) ration, $0.04.

Gain ($0.04), less extra cost ($0.14), gives net loss $0.10, daily net loss 0.43 cents.

RATIONS	Hay	Silage	Wheat bran	Dried distillers' grains	½ cottonseed meal ½ linseed meal	Milk	Butter	Money value of food	Cost of food for 100 lbs. of milk	Cost of food for 1 lb. butter	Proceeds from butter at 20 cents	Fertilizing value of food eaten
69 DAYS ON NO. 1 RATION VS. 69 DAYS ON NO. 3 RATION												
No. 1	932	1928	366	184		1153	80.5	13.57	117.7	16.9	16.10	9.38
No. 3	915	1898	181		366	1153	83.2	14.13	122.6	17.0	16.64	9.14
Differences in favor of No.(3) ration						0	+ 2.7	+0.56	+ 5.9	+ 0.1	+0.54	−0.24
Percentage difference						0	+ 3	+ 4	+ 5	+ 1	+ 3	− 3

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; No. 1 ration $24.32, No. 3 ration $24.70.

Difference in favor of No. 3 ration, $0.38.

Gain ($0.38), less extra cost ($0.56), gives net loss $0.18, daily net loss 0.38 cents.

COMPARATIVE VALUES OF VARIOUS RATIONS FROM THE FINANCIAL STANDPOINT

RATIONS	Hay	Silage	Wheat bran	Dried distillers' grains	½ cottonseed meal ½ linseed meal	Milk	Butter	Money value of food	Cost of food for 100 lbs. of milk	Cost of food for 1 lb. butter	Proceeds from butter at 20 cents	Fertilizing value of food eaten
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	$	cts.	cts.	$	$
69 DAYS ON NO. 1 RATION VS. 69 DAYS ON NO. 1 RATION												
No. 1 (1)...........	765	1656	866		186	1223	69.1	12.36	101.1	17.9	13.82	8.61
No. 1 (2)...........	790	1656	866		186	1209	69.5	12.48	103.2	18.0	13.90	8.70
Differences in favor of No. (2) ration............						—14	+0.4	+0.12	+ 2.1	+ 0.1	+0.08	+0.09
Percentage differences.........						— 1	+ 1	+ 1	+ 2	+ 1	+ 1	+ 1

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; No. 1 ration $21.64, No. 2 ration $21.76.

Difference in favor of No. 2 ration, $0.12.

Gain ($0.12), less extra cost ($0.12), gives net gain 0, daily net gain 0.

RATIONS	Hay	Silage	Wheat bran	Dried distillers' grains	½ cottonseed meal ½ linseed meal	Milk	Butter	Money value of food	Cost of food for 100 lbs. of milk	Cost of food for 1 lb. butter	Proceeds from butter at 20 cents	Fertilizing value of food eaten
46 DAYS ON NO. 3 RATION VS. 46 DAYS ON NO. 3 RATION												
No. 3 (1)...........	572	1094	111	224		746	43.1	8.61	115.4	20.0	8.62	5.58
No. 3 (2)...........	566	1097	114	230		746	43.8	8.70	116.6	19.9	8.76	5.63
Difference in favor of No. (2) ration...........						0	+0.7	+0.09	+ 1.2	— 0.1	+0.14	+0.05
Percentage differences.........						0	+ 2	+ 1	+ 1	— 1	+ 2	+ 1

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; No. 1 ration $13.62, No. 2 ration $13.79.

Difference in favor of No. 2 ration, $0.17.

Gain ($0.17), less extra cost ($0.09), gives net loss $0.08, daily net loss 0.17 cents.

RATIONS	Hay	Silage	Wheat bran	Dried distillers' grain	½ cottonseed meal ½ linseed meal	Milk	Butter	Money value of food	Cost of food for 100 lbs. of milk	Cost of food for 1 lb. butter	Proceeds from butter at 20 cents	Fertilizing value of food eaten
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	$	cts.	cts.	$	$

138 DAYS ON NO. 1 RATION VS. 138 DAYS ON NO. 2 RATION

RATIONS	Hay	Silage	Wheat bran	Dried distillers' grain	½ cottonseed meal ½ linseed meal	Milk	Butter	Money value of food	Cost of food for 100 lbs. of milk	Cost of food for 1 lb. butter	Proceeds from butter at 20 cents	Fertilizing value of food eaten
No. 1	1458	3091	660	332		1816	115.9	22.77	125.4	19.6	23.18	15.83
No. 2	1420	3024	327		629	1816	114.2	20.68	113.9	18.1	22.84	14.16
Differences in favor of No.(1) ration						0	− 1.7	−2.09	−11.5	− 1.5	−0.34	−1.67
Percentage differences						0	− 1	− 9	− 9	− 8	− 1	− 11

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; No. 1 $36.86, No. 2 $35.39.

Difference in favor of No. 1 ration, $1.46.

Gain ($1.46), less extra cost ($2.09), gives net loss $0.63, daily net loss 0.46 cents.

69 DAYS ON NO. 2 RATION VS. 69 DAYS ON NO. 2 RATION

RATIONS	Hay	Silage	Wheat bran	Dried distillers' grain	½ cottonseed meal ½ linseed meal	Milk	Butter	Money value of food	Cost of food for 100 lbs. of milk	Cost of food for 1 lb. butter	Proceeds from butter at 20 cents	Fertilizing value of food eaten
No. 2 (1)	1008	1656	185	346	20	1183	73.0	12.72	107.5	17.4	14.60	8.70
No. 2 (2)	1007	1659	186	366		1218	72.2	12.63	103.7	16.8	15.04	8.67
Differences in favor of No.(2) ration						+ 35	+ 22	−0.09	− 3.8	− 0.6	+0.44	−0.03
Percentage differences						+ 3	+ 3	− 1	− 4	− 4	+ 3	0

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; No. 1 ration $22.41, No. 2 ration $22.90.

Difference in favor of No. 2 ration, $0.49.

Gain ($0.49), plus extra cost ($0.09), gives net gain $0.40, daily net gain 0.58 cents

69 DAYS ON NO. 5 RATION VS. 69 DAYS ON NO. 5 RATION

RATIONS	Hay	Silage	Wheat bran	Dried distillers' grain	½ cottonseed meal ½ linseed meal	Milk	Butter	Money value of food	Cost of food for 100 lbs. of milk	Cost of food for 1 lb. butter	Proceeds from butter at 20 cents	Fertilizing value of food eaten
No. 5 (1)	744	1649		545		489	38.9	12.47	255.0	32.1	7.78	6.96
No. 5 (2)	732	1655		548		512	40.4	12.45	243.2	30.8	8.08	6.94
Differences in favor of No.(2) ration						+ 23	+ 15	−0.02	−11.8	− 1.3	+0.30	−0.02
Percentage differences						+ 5	+ 4	0	− 5	− 4	+ 4	0

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; No. 1 $13.26, No. 2 $13.58.

Difference in favor of No. 2 ration $0.32.

Gain ($0.32), plus lessened cost ($0.02), gives net gain $0.34, daily net gain 0.49 cents.

VIII. THE FEEDING VALUE OF PUMPKINS

The result of a brief trial of the relative feeding values of pumpkins and silage was outlined in the fourteenth report of this Station (pages 362-361). A second trial was carried out during the past winter, hay and pomace, however, being the alternates of the pumpkins.

FEEDING

Four cows several months in lactation were chosen and fed hay, a small ration of pomace, and either grain feeds Nos. 1 or 7 during the first and third periods. During the second, however, a third of the hay and all of the pomace were replaced by pumpkins. Although a considerable quantity was grown, they rotted badly, owing to inadequate facilities for storage. It was impossible to complete the period; hence the pumpkins were replaced by silage during the last few days. A careful survey of the data indicates that the nature of the outcome was not materially affected by this enforced change. The pumpkins were eaten at the rate of about 40 pounds a day. They were very wet, containing not much more food matter than does skimmilk. They were considerably drier than those fed two years ago, but carried much less protein and fat. They were perhaps a bit more mature.

COMPARISON WITH STANDARDS

No digestion experiments on pumpkins exist; hence comparisons cannot be made when these were fed.

Wolff.—Protein was scanty; all other nutrients were consumed in plenty or in excess.

Wolff-Lehmann.—Total dry matter was as usual and inevitably short, but digestible matter and nutrients was in excess of requirements. Since there were but 4 percent less dry matter eaten in the pumpkins than in the hay and pomace ration, the probabilities are that the cows had plenty of digestible food when pumpkins were fed.

RESULTS

The following table, summarized from those at various points in the appendix, shows the increase or decrease—expressed as percentages, total equalling 100—in dry matter eaten, in milk, total solids and fat given, and of products per 100 pounds of dry matter eaten, when pumpkins were fed in comparison with hay and apple pomace, mixed feeds Nos. 1 and 7 as concentrates being fed throughout, nutritive ratios ranging—when no pumpkins were fed—from 1:6.1 to 1:6.8 and averaging 1:6.4.

SUMMARY OF DIFFERENCE TABLES, ETC. (APPENDIX VI (*b*) AND VII)

RATIONS	Total dry matter eaten	Quantity of milk	Total solids, percent	Fat, percent	Quantity of total solids	Quantity of fat	Products per 100 pounds of dry matter		
							Milk	Total solids	Fat
Pumpkins (actual) ± hay etc. (calculated)...	−5	+6	0	−1	+6	+6	+10	+10	+11
92 days on pumpkins± 92 days on hay, etc.	−4	+7	0	0	+6	+6	+11	+11	+11

RESUMÉ

1. Six percent more milk, solids and fat were made when the pumpkins were fed than when they were omitted from the ration. And, since there was 5 percent less dry matter consumed at the same time, the product to the unit thereof was bettered 10 percent.

2. The quality of milk was uniform on both rations.

In the experiment reported two years ago the pumpkin ration made as much milk as a silage ration, and 5 percent more proportional to dry matter consumption. In this test it decidedly surpassed the hay and pomace diet. The cows seemed in no way harmed by the pumpkin feeding, nor was the butter the worse for it.

FINANCIAL CONSIDERATIONS

The financial outcome is shown on page 258. There seems to be no good basis for estimating the money value of the pumpkins, unless the same figure hitherto used for silage, soiling crops and the like be used, i. e. $3.00 a ton. This, however, seems too high a price to allot to so watery a product. Yet on the other hand, $2.00 a ton seems a small price to compensate one for growing the crop. Using this sum, however, for the purpose of comparison, it is seen that the pumpkin ration cost $1.38 in excess of the other, an amount more than enough to offset the decided gain. At $1.90 a ton the account would just balance, without gain or loss on either side. In the former experiment 2½ pounds were judged to be nearly an equivalent in feeding value to a pound of silage. In this test 3300 pounds with 700 pounds of silage took the place of 500 pounds of hay and 900 pounds of pomace. Allowing equal weights of corn silage and of pomace silage roughly to

offset each other, and bearing in mind the decidedly better yields obtained on the pumpkin ration, it seems fair to say that the equivalence of the pumpkins to the hay in these trials was about in the proportion of 6½ to 1.

Pumpkins at best can serve only as a fall or early winter feed. In spite of the good showing made it is doubtful whether as much dry matter or as cheap dry matter can be grown in pumpkins as is produced in the corn crop.

IX. NUTRENE

"Nutrene dairy feed" was offered in New England markets some thing over a year ago by Wogan Bros., of New Orleans. It was said to be a sugar-house by-product combined with wheat, corn and oat products. A sample critically examined by the Massachusetts Station was found to contain "molasses, absorbed by oat clippings or similar material, together with cottonseed hulls, some corn and a little cottonseed meal." The lot used in the feeding trial about to be discussed appeared to be of much the same general character.

Five cows were scheduled for use in a comparison of this material with the standard No. 1 (wheat bran, cottonseed and linseed meals) mixture. Four of the five struck. Three others were put in their places, and they, like their mates, protested. Powella, a farrow grade Jersey, making but 8 pounds of milk a day, ate her 8 pounds ration of Nutrene daily for six months and entirely without cavil. She held up her milk flow—what there was of it—save in the third period, giving as much in April and May as she did in December and January. Since her feeding was continuous, no comparison was possible. It was stated in the Massachusetts bulletin hitherto cited, that while "no exact experiments to determine the feeding value" were made, "it was fed to several cows with fairly satisfactory results," an outcome quite contrary to that obtained with our usually hearty eating cows.

"Nutrene" generally analyzes low in protein as compared with the rich concentrates which abound in New England markets. Two of the seven samples collected during the spring of 1902 carried over 23 percent, the remainder 17 to 18.5 percents. Samples analyzed at the Massachusetts station showed 14 and 16 percents. That used in the feeding experiment carried a little under 17 percent, which was its guaranty. It is evidently not calculated to narrow a ration.

Molasses is a good food for both man and beast. It is likely that it will be more largely used in cattle feeding in the future than in the past. Whether or not it will pay to freight low grade absorbents of molasses nearly 2,000 miles will depend on selling prices. Nutrene

was bought at $23. Had it been readily eaten and proved a good milk maker, it might have been worth buying at that price.

X. DISTILLERS' DRIED (RYE) GRAINS

The rye grains differ from the alcohol grains hitherto described (page 238) in their source and in carrying much less protein and much more carbohydrates. Their sale is not being pushed at present in eastern markets by the manufacturers, who prefer to sell the XXXX brand of higher grade.

It was not expected to use the rye grains during the past winter, but the unfortunate error hitherto alluded to furnishes a single comparison of the feeding value of these grains as compared with the No. 1 mixture.

The cow Dahlia was fed the rye grains during most of the experimental portion of the second period. During the last few days, however, she ate the correct No. 3 mixture. Hence, the comparison will serve roughly to measure values.

She ate about as much total dry matter and a little more digestible dry matter when fed the No. 3 mixture than when No. 1 was used. But she made 8 percent less milk of somewhat poorer quality and 10 percent less butter on the grains than on the cottonseed-linseed mixtures.

Four cows, Fresno, Inez, Vivian and Rose?, were continuously fed No. 3. They consequently received during about half of period I and during all of period III the correct mixture and during the major part of period II the wrong one. One can from their records form some sort of rough idea of the relative merits of the rye and the alcohol grains.

Three of the cows made 8 percent less milk and all 4 cows, 9 percent less butter in the second period than on the average of the first and third. There was no great dropping off in eating except in one case, where 8 percent less dry matter was consumed.[1]

Two of the four cows gained from 5 to 6 percent in milk and butter yield in the third (alcohol grains) period over its predecessor, which was five weeks earlier in lactation. One of the other two, continuously fed a very low grain ration, held her own without shrinkage, the other lost 7 percent.

Since rye grains are not offered on the market the financial outcome cannot be stated. Neither ought it to be stated under the condi-

[1] The data for periods I and II on these grains are not published in the appendix.

tions of this trial, which, it should be once more recalled, are such as not to warrant dogmatic statements as to relative values.

XI. HEAVY FEEDING WITH APPLE POMACE SILAGE

Two years' trials, the results of which have hitherto been discussed both in report and bulletin,[1] have amply proved that ensiled apple pomace has nearly the value of corn silage as a feed for dairy cows, when fed in moderate quantities, say 15 pounds a day. It was not so certain that it could be fed either with profit or with safety in large quantities. Hence several cows with good appetites were chosen, to which from 24 to 35 pounds of pomace silage a day were fed, while on that ration, and equivalent amounts of corn silage when on that feed. Several of these cows were originally scheduled to be fed "Nutrene" (see page 252), but declined to accommodate themselves to such scheduling, and they ultimately found refuge in pomace silage and No. 7 feed.

FEEDING

Eight cows, one fresh, four from four to six months in lactation, and three far along therein, were used in this test. One was fed corn silage continuously, one pomace silage continuously and six in alternation. They were fed all they could take in addition to an 8 pound grain feed and a 10 to 12 pound hay ration. This was 24 pounds daily fed each of five cows, 30 pounds for one cow, and 35 pounds for each or two. One of the latter was the cow continuously fed pomace silage. In no case was the slightest ill effect observed, either to cow or to product, which seemed attributable to the pomace feeding. Naomi developed actinomycosis (lump jaw) in the spring and Eva, the cow continuously fed the heavy pomace ration, was stricken with milk fever on calving in the late spring, two months after she ate her last mouthful of pomace. But there is no ground for attributing either of these misfortunes to the feeds.

COMPARISON WITH STANDARDS

Wolff.—Yuba's eating was standard or very slightly sub-standard. The other cows ate total and digestible food considerably in excess of standard needs. Naomi and Minta Bella eating the No. 1 ration got enough protein to meet the standard requirements; the other five, enough as a rule when on corn silage and too little when on pomace.

[1] Vt. Sta. Rpts., 3, p. 74 (1889); 14, pp. 359-362 (1901); 15, pp. 310-314 (1902); Bul. 97 (1902).

Wolff-Lehmann.—Every cow ate in excess, and some much in excess, of standard needs for digestible food and the several digestible nutrients. All but Yuba and Naomi ate more total dry matter than the standard calls for, a very unusual thing, one which testifies to their heavy roughage feeding.

RESULTS

The following table, summarized from various points in the appendix, shows the increase or decrease—expressed in percentages, total equalling 100—in dry matter eaten, milk, total solids, and fat given, and of products per 100 pounds of dry matter, both in the total and the grain rations, when corn silage was fed in comparison with apple pomace silage—nutritive ratios ranging from 1:4.8 to 1:6.0 and averaging 1:5.3 when corn silage was fed and from 1:5.3 to 1:7.4 and averaging 1:6.6 when pomace silage was fed; hay as roughage and No. 1 as the concentrate being fed throughout.

SUMMARY OF DIFFERENCE TABLES, ETC. (APPENDIX VI (*b*) AND VII)

RATIONS	Total dry matter eaten	Dry matter eaten in concentrates	Quality of milk	Total solids, percent	Fat, percent	Quantity of total solids	Quantity of fat	Products per 100 pounds of dry matter: In entire ration: Milk	In entire ration: Total solids	In entire ration: Fat	In experimental feed: Milk	In experimental feed: Total solids	In experimental feed: Fat	Ratio of fat to solids-not-fat
Pomace (actual) ± corn (calc)	— 3	—12	0	0	0	0	0	+ 3	+ 3	+ 3	+13	+13	+13	
Corn (actual ± pomace (calc)	+ 8	+22	+ 9	+ 1	+ 2	+ 9	+10	+ 1	+ 1	+ 3	—11	—10	—10	
276 days' feeding on corn ± 276 days feeding on pomace	— 5	—15	— 3	0	— 1	— 4	— 5	+ 2	+ 1	+ 0	+14	+13	+12	+ 1

RESUMÉ

1. There was from 3 to 5 percent less milk and butter made when the corn silage replaced the pomace silage.

2. There was no essential difference in the quality of the milk made on the two rations. What little difference existed was in favor of the pomace ration.

3. Practically the same production to the unit of dry matter was made on each ration.

The poor quality of the 1902 corn silage previously alluded to was, undoubtedly, a factor in this result.

FINANCIAL CONSIDERATIONS

In the 1902 trials with seven cows the corn silage ration produced butter, skimmilk and plant food in excess of that supplied by the pomace ration to the value of $1.28. But it cost $2.93 more. The use of the pomace saved a cent a day per cow.

The financial outcome of the present year is shown below. It is assumed, as hitherto and for the purpose of comparison, that apple pomace costs at the farm one dollar a ton. This sum would probably pay for the hauling and ensiling, but would not permit much to be paid for it at the mill.

The pomace silage ration fed 276 days made 3 percent more milk and 5 percent more butter than did its competitor fed for the same length of time. It cost, moreover, $7.83 less. The extra butter it made was worth $2.84 and the extra skimmilk about 25 cents. Its plant food content, however, was less than that of the corn silage ration. Its total extra production,—$2.09—plus its lessened cost—$7.83—make a total gain of $9.43, or nearly three and a half cents a day. If plant food and skimmilk are not held to be assets, and butter only is counted, the relative gain is even greater, $2.84+$7.83=$10.67 ÷276=3.87 cents daily gain.

In the present trials pomace silage outranked corn silage, even if the full money valuation of the latter—three dollars a ton—be applied to it. The two rations would then have cost within five cents of each other and the extra production of the pomace ration, worth $2.09, would have been equivalent to a gain of three-fourths of a cent daily.

This phenomenal result seems to be due to two things: to the inherent value of apple pomace as a food for cows, and to the poor quality of the immature corn silage. The outcome is strong testimony to the value of this product and indicates that the more is fed (up to the limit of healthful production), the more the profit.

The money value of apple pomace may be figured out in another way. The values allotted to the butter, to skimmilk and to two-thirds of the fertilizing ingredients in the experimental feeds, pomace and silage, were $75.09 and $73.57 respectively. Subtracting from these sums the estimated costs of the hay and grain, $38.53 and $38.60, leaves as sums which may be used for purposes of comparison $36.51 and $34.97. The amounts of corn and of pomace silages fed were 7505

and 7387 pounds respectively. A small amount of corn silage (101 pounds) was fed during the pomace periods, but this was so small an amount that its effect may be ignored without endangering the accuracy of the deductions.

A fair comparative—but by no means an absolute—showing may be made by proportion:

$$7505 : 2000 :: 34.97 : x = 9.33.$$
$$7387 : 2000 :: 36.51 : x = 9.88.$$
$$9.33 : 9.88 :: 100 : x = 106.$$

If the reasoning on which this calculation is based is correct the feeding value of the pomace eaten this year is as great as or greater than that of the silage. In last year's trials the relation thus figured out was 100 : 100 and in the previous year's trial, 100 : 84. The corn silages, however, were far superior both years to that fed during the past winter.

In whatever way the matter is figured out, pomace at a dollar a ton at the barn is a bargain, and at a considerably higher sum is a fair equivalent of corn silage. The four years of trials at this Station lead it to urge farmers to use it freely. It should be fed lightly at first, however, until the cows get accustomed to it, then as high as 35 pounds daily may often be fed without harming the cow or depleting the pocket book.

COMPARATIVE VALUES OF VARIOUS RATIONS FROM THE FINANCIAL STANDPOINT

RATIONS	Hay	Silage	Wheat bran	Dried distillers' grain	Dried brewers' grains	Milk	Butter	Money value of food	Cost of food for 100 lbs. of milk	Cost of food for 1 lb. butter	Proceeds from butter at 20 cents	Fertilizing value of food eaten
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	$	cts.	cts.	$	$
276 DAYS ON CORN SILAGE VS. 276 DAYS ON APPLE POMACE SILAGE												
Corn silage	3052	7505		1453	304	4529	298.3	49.81	110.0	16.7	59.66	83.10
Apple pomace silage	3066	101	7387	1453	303	4685	312.5	42.47	90.5	13.6	62.50	81.58
Differences in favor of pom. ration						+ 156	+14.2	—7.34	—19.5	— 3.1	+2.84	—1.52
Percentage differences						+ 3	+ 5	— 15	— 18	— 19	+ 5	— 5

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; corn silage ration $89.47, apple pomace $91.56.

Difference in favor of apple pomace, $2.09.

Gain ($2.09), plus lessened cost ($7.34), gives net gain $9.43, daily net gain 3.42 cents.

RATIONS	Hay	Silage	Wheat bran	Dried distillers' grain	Dried brewers' grains	Milk	Butter	Money value of food	Cost of food for 100 lbs. of milk	Cost of food for 1 lb. butter	Proceeds from butter at 20 cents	Fertilizing value of food eaten
92 DAYS ON POMACE RATION VS. 92 DAYS ON POMACE SILAGE RATION												
Pomace sil. (1)	1754		915	487	247	135.8	71.6	17.26	127.1	24.1	14.82	9.55
Pomace sil. (2)	1761		915	487	247	130.2	69.6	17.30	132.9	24.9	13.92	9.57
Differences in favor of No. (1) ration						— 56	— 2.0	+0.04	+ 5.8	+ 0.8	—0.40	+0.02
Percentage differences						— 4	— 3	0	+ 5	+ 3	— 3	0

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; pomace (1) ration $23.01, pomace (2) ration $22.52.

Difference in favor of pomace (1) ration, $0.49.

Gain ($0.49), plus lessened cost ($0.04), gives net gain 0$0.53, daily net gain 0.58 cents.

RATIONS	Hay	Silage	Wheat bran	Dried distillers' grain	Dried brewers' grains	Milk	Butter	Money value of food	Cost of food for 100 lbs. of milk	Cost of food for 1 lb. butter	Proceeds from butter at 20 cents	Fertilizing value of food eaten
92 DAYS ON HAY, ETC., RATION VS. 92 DAYS ON PUMPKIN RATION												
Hay etc. ration	1659		920	487	248	1386	72.2	16.44	118.5	23.1	14.44	11.38
Pumpkin ration	1151	718	3296	487	248	1477	76.7	17.32	120.6	23.2	15.34	11.62
Differences in favor of pump. ration						+ 91	+ 4.5	+1.38	+ 2.1	+ 0.1	+0.90	+0.22
Percentage differences						— 7	+ 6	+ 7	+ 2	0	+ 6	+

Total value of butter, skimmilk and two-thirds of fertilizing ingredients; hay ration $24.46, pumpkin ration $25.66.

Difference in favor of pumpkin ration, $1.20.

Gain ($1.20), less extra cost ($1.38), gives net loss $0.18, daily net loss 0.20 cents.

XII. EXPERIMENTAL ERROR

There is accumulated yearly[1] in the regular course of the feeding trials a greater or less volume of data touching the experimental error involved in the alternate method of conducting feeding trials. To discuss it at length is but rethreshing old straw; but it seems well worth while devoting a page or two to it yearly for the sake of putting it upon permanent record.

Twenty-three cows were fed unchanging rations during the course of the trials. All but one of these were used in the test which had to do primarily with the comparisons of methods (see succeeding article). If, however, their records be treated as if they were fed different rations in alternate periods, a measure of the extent of experimental error is at hand. The large number of cows distributed among the sundry trials makes quite a formidable array of figures.

All sorts of cows were included, old, middle-aged and young, fresh cows, cows in mid-lactation and those far along towards calving. Those fed the two low and very low grain rations sometimes ate less dry matter than standards called for, but practically all the others, when judged by either standard, ate as much as the law allowed or more. But whatever the eating, whether up to or below standard, it was essentially uniform week in and week out.

RESULTS

The following table, summarized from those at various points in the appendix, shows the increase or decrease—expressed as percentages, total equalling 100—in dry matter eaten, in milk, total solids and fat given and of products per 100 pounds of dry matter eaten, both in the total ration and in the grain ration when unaltered rations consisting of hay and corn or apple pomace silage as roughages and sundry mixed feeds as concentrates were fed throughout, nutritive ratios ranging widely among the several cows, but for each cow remaining closely uniform.

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[1] See footnote page 319.

SUMMARY OF DIFFERENCE TABLES, ETC. (APPENDIX VI (b) AND VII)

RATIONS	Reference number	Dry matter	Dry matter in grain rations	Quantity of milk	Total solids, percent	Fat, percent	Quantity of total solids	Quantity of fat	Products per 100 lbs. of dry matter: In entire ration: Milk	In entire ration: Total solids	In entire ration: Fat	In grain ration: Milk	In grain ration: Total solids	In grain ration: Fat	Ratio of fat to solids-not-fat
MIXED FEED NO. 2															
Very low ration	1	−1	−1	+2	0	−1	+2	+1	+3	+2	+2	+ 3	+2	+ 2	
Low "	2	−1	−1	+9	0	0	+8	+8	+9	+8	+8	+ 9	+9	+ 8	
Medium "	3	+1	0	−1	+1	+1	+1	+1	−1	0	0	− 1	0	+ 1	
MIXED FEED NO. 3															
Very low ration	4	−3	0	0	0	−2	+1	−2	+4	+3	+2	0	+1	− 2	
No. 4	5	0	+2	−6	0	−1	−6	−6	−5	−6	−6	− 7	−7	− 7	
No. 2	6	0	−1	−1	+1	+1	0	+1	−1	0	+1	+ 1	+2	+ 2	
No. 3	7	−5	−7	+2	−1	−3	+1	−1	+7	+6	+4	+10	+9	+ 6	
No. 1	8	−1	0	−2	0	+1	−2	−1	−2	−2	−1	− 2	−2	− 1	
No. 3	9	−4	−8	−2	+1	+1	−1	−1	+3	+4	+4	+ 1	+3	+ 3	
No. 1	10	−4	−1	−2	+1	+1	−2	−1	+2	+3	+3	− 1	−1	0	
No. 2	11	−1	−1	0	0	0	0	0	0	0	0	0	0	0	
Pomace silage	12	+2	0	+7	+1	+2	+9	+9	+5	+6	+7	+ 2	+8	+ 4	
Corn silage	13	−2	+5	+3	+1	0	+3	+2	+5	+5	+4	− 2	−2	− 3	
No. 5	14	−1	0	−6	+1	+1	−5	−4	−5	−4	−8	− 6	−5	− 6	
MIXED FEED NO. 2															
69 days on very low ration ± 69 days on same	15	−3	−1	−4	0	−2	−4	−6	−1	−2	−4	− 4	−5	− 6	+2
69 days on low ration ± 69 days on same	16	−1	+1	+2	0	0	+1	+2	+2	+2	+2	0	0	0	−1
69 days on medium ration ± 69 days on same	17	−1	+3	+1	0	+2	0	−1	+1	+1	0	− 2	−2	− 4	+3
MIXED FEED NO. 3															
46 days on very low ration ± 46 days on same	18	0	0	−1	+1	+1	0	0	−1	0	+1	− 1	0	0	−1
69 days on No. 4 ± 69 days on same	19	−1	+4	−3	−1	−4	−4	−7	−2	−4	−7	− 7	−8	−12	+5
92 days on No. 2 ± 92 days on same	20	−2	−5	+2	0	−1	+2	+1	+3	+3	+3	+ 4	+3	+ 3	+1
69 days on No. 1 ± 68 days on same	21	+3	0	−1	0	+1	−1	−1	−4	−4	−3	− 1	−1	− 1	−2
46 days on No. 3 ± 46 days on same	22	0	+3	0	0	+2	0	+2	−1	0	+1	− 3	−3	− 1	−2
69 days on No. 2 ± 69 days on same	23	−1	+2	+3	0	0	+3	+3	+3	+3	+3	+ 2	+2	+ 2	+1
92 days on pom. ± 92 days on same	24	0	0	−4	+1	+1	−4	−3	−4	−4	−2	− 4	−3	− 2	−1
69 days on No. 5 ± 69 days on same	25	−3	−1	+5	0	−2	+5	+4	+8	+7	+7	+ 6	+7	+ 7	+4

Twenty-five sets, including 336 separate figures. These distribute as follows: 62 zeros, 91 ones, 57 twos, 39 threes, 29 fours, 41 fives to sevens, 16 eights and higher. Seventy-five percent of the figures are threes or less. Seventeen percent are fives or higher. The average value is 2.47.

This is a very poor showing, far inferior to last year's fine exhibition with 20 sets and 270 figures.

A survey of the data shows that eight of the twenty-five sets contain high figures. Their existence is in every case readily explained

and they serve to point a moral. The numbers in parentheses are reference numbers.

(2) Record of one cow, Flora, whose erratic milk flow (372, 400, 424, 376, 226) in successive periods on very even eating was most anomalous.

(5) (19) Record of one cow, Stella, whose milk flow in the first period was very large as compared with that in other periods (642, 511, 479, 492, 540). Yet she ate somewhat less in the first than in subsequent periods.

(7) A single comparison of a single cow, Vivian, who ate less but gave more in period IV than in periods III and V.

(12) A record of four cows, all well along in lactation. The comparisons were all of the latter periods of IV as against the mean of III and V. One cow, Nancy B., made an extra good yield in period IV, in which she ate rather more hay than usual. She is largely responsible for the wideness of the data.

(14) (25) Record of a single farrow cow, Powella, giving not to exceed 8 pounds a day. In the third period she dropped to 6 pounds a day, returning later to the former flow.

(15) Record of a single cow, Atalanta. By one method of comparison the differences are not excessive, but by the other they were somewhat large, the higher figures accumulating on one side, the lower on the other.

Five of the six wide results are caused by the eccentricities of single cows, whose records stand alone. In every case but one (10 of 25 sets) where more than one cow furnishes data good results were attained.

If now we combine the records of these cows, used in sundry experiments but fed the same feeds, we have a very different showing. Eighteen of the twenty-five sets reduce to six in number, in each of which from 3 to 6 cows figure. The eighteen sets, before being thus consolidated, contained 14 poor, 9 bad and 11 very bad figures. The consolidation reduces these figures to 8, 3 and 0. Instead of there being but 75 percent of good results, 86 percent seems above reproach.

This year's record is more irregular than any hitherto obtained. This is its merit rather than its defect; for more clearly than in any of the many trials previously reported is shown the danger of using but two or three animals in a feeding trial.

The writer does not feel that such results obtained with single animals throw doubt on the validity of the data obtained when the selection of animals is made with care, the number used is sufficient

(which he believes should never be less than four) and the feeding periods are from four to six weeks long.

XIII. SUMMARY

The details given in the foregoing fifty pages may be summarized under their respective reference numbers and headings as follows:

1. *The nature of the problems studied.*—Forty-eight cows were used in the feeding trials, which lasted 25 weeks and were meant to determine so far as it is possible for single trials to do:

(*a*) The effect on the quantity and quality of milk and on the economy of production, of very low, low, and medium grain feeding; also the limit of profit in the addition of grain to a ration—pages 221-237.

(*b*) The safety and profit of feeding clear undiluted distillers' dried grains—pages 237-240.

The relative feeding values of:

(*c*) Distillers' and brewers' dried grains—pages 240-242.

(*d*) Distillers' dried grains and cottonseed-linseed meals—pages 242-244.

(*e*) Brewers' dried grains and cottonseed-linseed meals—pages 244-246.

The feeding value of:

(*f*) Pumpkins—pages 250-252.

(*g*) Nutrene dairy feed—pages 252-253.

(*h*) Distillers' dried rye grains—pages 253-254.

(*i*) Apple pomace silage fed in large quantities—pages 254-257.

(*k*) The extent of experimental error in feeding trials—pages 259-262.

2. *Methods, details, etc.*—The feeding periods were five weeks long and many different rations were used. Hay, corn and apple pomace silages and pumpkins were the roughages used. Fifty-three cows were started in the experiments and the records of 48 were deemed safe to use. Full records were made, including weights of cows, fodders and feeds, milk, etc., barn temperatures were taken and constant analytical check was kept upon every phase of the work throughout the entire 25 weeks. These are in part exhibited on pages 219-221 and also in the appendix to this report.

3. *Is 2 pounds of grain daily enough?* Twelve cows were fed to determine whether a 2 pound grain ration proved as profitable as one of four or eight pounds. The outcome was as follows:

Quantity.—The more grain, the more milk, total solids and fat. The gains averaged 10 percent when the 4 pound ration replaced the 2 pounds feed, and about 18 percent when the 8 pound was used.

In these trials a slight lowering of the quality of the milk accompanied the use of a very low grain ration.

Economy of production.—A pound of dry matter made more milk, solids and fat on the very low ration than on the medium. As between the low and the very low rations the outcome was nearly equal.

Live weight.—About two-thirds of the cows responded to radical changes in the amount of grain fed by gaining flesh or losing it, according as feed was added or withdrawn. Those uniformly fed as a rule held their own.

Does it pay to feed as little as 2 pounds of grain daily?—When 2 pounds of grain were fed instead of 4, $3.32 were saved on grain bills and $3.74 lost in butter not made; when 2 pounds of grain were fed instead of 8, $8.40 were saved on grain bills and $6.42 lost in butter not made.

Since a 4 pound grain ration paid better than a 2 pound one when the butter increase alone is considered, so much the better does it appear when skimmilk and manurial constituents are taken into account. Since the 8 pound ration came within $2.00 of meeting extra grain bills by extra butter yield, and its skimmilk and manurial values exceeded those of the very low ration by nearly $5.00, the heavier ration may justly be counted the more satisfactory.

4. *Distillers' dried grains* fed clear and undiluted afforded 4 percent less product of unchanged quality than did a ration one part in three of which was wheat bran. The latter made a financial gain of three-quarters of a cent daily per cow over the competing ration. The cows rarely ate more than 7 of the 8 pounds of the clear grains. The practice of feeding these grains clear and undiluted does not seem a wise one. Pages 237-240.

5. *Distillers' and brewers' dried grains.* The former made 5 to 8 percent more milk and butter, but owing to the low cost of the brewers' grains, the latter proved the more economical. Pages 240-242.

6. *Distillers' dried grains and cottonseed-linseed meals.* The rations proved equally efficient. The second named was, however, the more economical one. Pages 242-244.

7. *Brewers' dried grains and cottonseed-linseed meals.* The rations proved equally efficient, but the brewers' grains at $19 a ton were

so cheap that economically they ranked ahead of the cottonseed-linseed combination. Pages 244-246.

8. *Pumpkins* when added to a hay ration increased the milk flow 6 percent. Pages 250-252.

9. *Nutrene* dairy feed was not relished, was eaten by only one cow and does not seem a desirable addition to the list of dairy feeds. Pages 252-253.

10. *Distillers' dried rye grains* made less milk and butter than did the alcohol grains, a result which was foreshadowed by their analysis. Pages 253-254.

11. *Apple pomace silage* fed freely—upwards to 35 pounds per cow daily—made more milk and butter than did immature corn silage. The butter was in no way injured. It is probably worth as much for feeding cows as is immature corn silage and, perhaps, three-quarters as much as is corn silage. Pages 254-257.

12. If conditions favor, the *experimental error* in feeding trials conducted by the alternation system is but slight; if however, the number of cows used is limited or other untoward circumstances occur, it may reach serious proportions. Pages 259-262.

A COMPARISON OF FEEDING TRIAL METHODS

(Third Article)

It has been the custom of this Station to repeat and re-repeat the investigations of important matters, to continue for years to work along certain restricted lines, to concentrate rather than to scatter effort. Thus, for example, the botanist has yearly since 1890 studied and written concerning potato maladies, while the former horticulturist rode a single hobby, the plum. Similarly the writer has given attention for a long time to a dissection of the current methods used in conducting feeding trials with cows, and has contributed matter on this topic to six of the last seven reports.[1] The present article is the third of its kind, given under the same caption, designed to add to our knowledge as to the trustworthiness of the means now in use whereby the feeding values of rations are measured.

The methods more commonly employed to this end, their faults and their virtues, and the reasons why both results and deductions are often accorded but little weight, have been outlined in the previous articles,[2] and need not be repeated here. It may not be amiss, though

[1] Vt. Sta. Rpts., 9, pp. 225-228 (1895); 10, pp. 141-161, 165-167 (1897); 11, pp. 320-330, 339-340 (1898); 12, pp. 286-287 (1899); 14, pp. 365-366, 369-375 (1901); 15, pp. 314-316, 318-327 (1902).

[2] Vt. Sta. Rpts., 14, pp. 369-375 (1901); 15, pp. 318-327 (1902).

perhaps useless, to remark that a study of the validity of systems of measurement is worth while, even though it may serve to throw upon them more doubt than light. In the language of last year's article, "whether the results of this line of work are positive or negative, constructive or destructive, whether they make for betterment or simply reveal weaknesses, they ought to prove of service. Feeding trials can never yield results as exact as those obtained in laboratory work; but they may furnish data accurate enough for practical purposes; and it is conceivable that this likelihood may be enhanced by the disclosure of defects or the affirmation of soundness."

As a further contribution in this line are offered the results of a third year's comparative trial of the feeding methods denominated in the previous articles as the alternating and the combined continuous and alternating systems.

Without reiterating the comments made upon these methods, it may be well to state that these terms are applied, the one to trials in which competitive rations are fed to the same animals in alternate periods, and the other to trials in which the animals are divided into groups, to one of which is fed continuously one ration, while to the other are fed in alternate periods two rations, one of which is the same as that fed the animals in the other group.

In planning the feeding experiments of 1902-1903, it was designed to measure the relative values of very low, low and medium grain feeding, of mixed feeds 1, 2, 3, 4, and 5, and of corn silage and apple pomace silage, by two methods, that of alternation and that of combined continuity and alternation. Forty-eight cows were chosen for these tests, 24 of which were to be fed different rations alternately, while 24 were destined to eat continuously a uniform ration. In other words, these cows, one from each set, were paired one against another in 24 couples.

The original matches were made as a result of a careful study of the records of performance of previous years, extending in some cases as far back as 1894, of stages of lactation, etc. An effort was made in each case to link the records of cows which might be expected to yield, during the course of the feeding trials, approximately the same amounts of milk, solids and fat,—more particularly the two latter,—and as nearly as might be like solid and fat percentages. Thus, for example, Elsa and Flora were an ideal couple. (15, p. 268).

Naturally some matches were better than others. Also, and inevitably, some which promised well did less well than they promised, while in some cases the outcome proved better than was anticipated.

Several of the original matches for one reason or another were rendered unserviceable. The unfortunate error at the feeding barn, referred to in the previous article, very seriously reduces the available data for these comparisons and, by minimizing the number of comparisons, increases the likelihood of errors. Shrinkage preparatory to drying off, or dainty eating of experimental feed were also responsible for several failures. The failure of either member of a pair destroys the usefulness of both, unless other mating can be made.

Thus it happens that only 12 of the original 24 couples survived as planned. Inasmuch, however, as each ration was fed to several cows, to some continuously and to some in alternation, it was possible, when the experiments were completed, to construct several other couples, using the actual rather than the anticipated records for this purpose. Thus the records of one cow might serve as a basis for several comparisons. Thus were made two sets of couples for purposes of calculation, those made in the fall before the tests began, and those constructed the following summer, using actual performance instead of anticipation as a guide in coupling.

A concrete case will serve to make this matter plain. The cow Ursula (line 6, table, page 268) was judged before the trials began to be likely to give about as much milk, solids and fat as would the cow Star Bright (line 37, table, page 268), if each were fed alike. Hence they were scheduled as couple 8 (see "couple number" column in table), and the former was fed continuously the No. 2 ration while the latter alternated between Nos. 2 and 3. As a matter of fact, however, the judgment was not borne out. Ursula made during period I, 15 percent more milk than did her mate, and "couple 8" proved to be at best but a "fair" one. When the records of actual performance were scanned in late May, it was found that Max Belle (line 5, table, page 268), continously fed No. 2, had made a record fairly comparable with that of Star Bright, and hence a new coupling was made, scheduled as "4."

Twelve primary and 21 secondary couplings, or 33 in all, were available. Some of these are good ones, and some poor, or, even, bad. Sometimes the secondary couplings proved better than the primary ones, "hindsight" being better than foresight.

A careful survey of the records made in the first of the three periods necessary to make a completed record for each cow, leads to the following classification of the matches: good 9, fair 11, indifferent 4, bad 9.[1]

[1] Good, 1, 2, 5, 6, 12, 14, 15, 16, 29.
Fair, 3, 4, 7, 8, 9, 13, 17, 21, 22, 32, 33.
Indifferent, 11, 26, 27, 28.
Bad, 10, 18, 19, 20, 23, 24, 25, 30, 31.

The table on the following page affords some clue of the condition of the 35 cows used in this series of comparisons as to their fitness for the purpose. It shows the coupling numbers, age, the number of days since calving at the time when the initial comparison period began as well as the number of months elapsing before the next calving, designates the number of the initial period, and finally shows the actual record in milk, solids and fat made in the first period in which the coupled animals were similarly fed.

TABULATED STATEMENT SHOWING COWS USED IN COMPARATIVE TRIALS OF METHODS

Reference Number	NAME OF COW	Couple number	Age	Days since calving	Next calving, months	Period	Weight	Milk	Total solids	Fat	Total solids	Fat	Nature of rations
							lbs.	lbs.	%	%	lbs.	lbs.	
1	Pomona	1, 5	11	6		I	799	389.1	15.34	5.55	59.70	21.61	m. vl.
2	Pomona	14	11	41		II	793	366.3	14.41	4.89	52.79	17.91	vl. m.
3	Lucerne	2, 6, 13	9	65		I	803	371.9	14.60	5.14	54.30	19.11	vl. m.
4	Lucerne		9		9	II	817	381.4	15.54	5.74	59.26	21.86	m. vl.
5	Max Belle	1, 2, 4	10	41		I	913	432.7	15.17	5.40	65.66	23.37	m.
6	Max Belle	3	10	111		III	900	377.5	15.86	5.89	59.89	22.25	m.
7	Ursula	5, 6, 8	6			I	980	430.7	15.13	5.41	65.13	23.29	m.
8	Atalanta	11, 12, 13, 14	13	137		I	955	430.6	12.21	3.58	52.57	15.42	vl.
9	Maid Marian	12, 16	9	160		I	888	354.9	13.71	4.73	48.66	16.79	l. vl.
10	Elsa	11, 15	5			I	878	376.9	14.57	5.19	54.94	19.55	vl. l.
11	Flora	15, 16	13	140		I	873	372.7	14.30	5.02	53.30	18.69	l.
12	Linnet	17	2	25		III	523	379.3	13.37	4.30	50.73	16.32	vl. l.
13	Inez	17	10	85		III	873	403.4	14.82	5.35	59.77	21.57	vl. l.
14	Serena	29	6	60		II	845	511.2	13.75	4.47	70.27	22.87	4-3
15	Stella	29, 30	5	52		II	807	511.1	13.60	4.22	69.48	21.56	4
16	Sonoma	31	4	44		III	872	562.4	14.57	5.10	81.92	28.71	4-3
17	Stella	31	5	83		III	829	478.9	13.98	4.66	66.94	22.30	4
18	Rosel	26, 27	6	261	6	III	1003	412.8	14.68	5.13	60.60	21.18	3
19	Serena	26, 28	5	91		III	845	501.3	13.78	4.50	69.07	22.58	3-4
20	Pretoria	28	6	146	9	III	890	404.6	13.55	4.55	54.82	18.39	3
21	Monterey	30	4	233	5	II	903	376.2	14.03	4.71	52.77	17.73	4-3
22	Vivian	25	7		6	III	872	352.4	13.66	4.47	48.12	15.74	3
23	Janice	25	6		8	III	822	261.6	15.03	5.25	39.32	13.73	3-2
24	Juanita	3, 7	5	180	5	III	777	315.7	16.38	6.28	51.72	19.83	2-3
25	Katrina	9	2	114		II	625	187.1	15.58	5.72	29.14	10.70	2
26	Beautina	9, 10	11	346	4	II	977	243.1	14.56	5.07	35.39	12.33	2-3
27	Bertha	10	3	282	9	II	938	152.3	15.80	5.97	24.05	9.09	2
28	Ursula	7	6	180	7	III	970	388.0	14.80	5.28	57.42	20.49	2
29	Primrose	21	10	46		III	955	420.5	13.68	4.53	57.52	19.04	1-3
30	Rosemary	21, 22	8	49		III	843	483.8	13.77	4.54	66.64	21.97	1
31	Goldenrod	27	11	229		III	1016	379.2	17.48	7.00	66.29	26.56	3-1
32	Goldenrod	19	11	198		II	1021	348.6	17.08	6.60	59.53	22.99	1-3
33	Rosemary	19, 20	8	18		II	838	565.3	13.67	4.28	77.24	24.21	1
34	Lavender	23	5		7	I	913	270.6	15.75	6.23	42.61	16.86	1
35	Star Bright	20	6	121		II	1000	335.5	15.99	5.93	53.64	19.91	1-2
36	Lorna Doone	18, 23	3	295	8	I	730	201.4	13.87	4.59	27.93	9.25	1-2
37	Star Bright	4, 8	6	90		I	990	361.6	15.71	5.72	56.82	20.67	2-1
38	Dorothy	22, 24	3	9		III	892	530.2	14.46	4.78	76.69	25.32	1-3
39	Edith	24	5	29		III	785	712.3	14.19	4.92	101.05	35.06	1
40	Santa Clara	32	4	213	7	I	789	312.3	16.26	6.14	50.77	19.16	Pom. Si.
41	Eva	32	10	350	6	I	869	334.3	17.60	7.03	58.81	23.51	Pom.
42	Mermaid	33	7	316	6	I	848	355.2	17.08	7.03	60.65	24.98	Si. Pom.
43	Minta Bella	33	11	201	5	I	773	338.3	15.87	6.14	53.69	20.77	Silage
44	Una	18	3	365	5	I	638	222.6	16.46	6.45	36.65	14.36	

The plan of experimental feeding, the comparison with standards and the general results were discussed in the previous article. It simply remains, therefore, for us to consider the final results as measured by the two methods of experimentation.

The article in the fourteenth report on this subject contained a table showing the percentage differences[1] in the dry matter consumption, in the quality of the milk, in the production of milk, total solids and fat and in the proportions of the same to the unit of dry matter. It showed this for both sets of cows, the animal first named in each case having been fed continuously on one ration and the one second named having been alternated between rations. It likewise gave the results following a change in the ration fed, as for instance a change from the low to the medium feeding. These form the measures of the value of the ration.

This table was omitted in last year's article and will be again omitted now, for, if included, it would cover several pages solidly with figures. It is thought that it would be quite as well to give one example of the determination of the effect of the ration by the combined method and to deal in a later tabulation solely with the averages.

TABULATED STATEMENT COMPARING THE TWO METHODS

Showing the increase or decrease, as the case may be, of the record of each cow in period III, as compared with the average of the records of periods II and IV.	Number of period of comparison	Total dry matter in entire ration	Total dry matter in experimental feed	Milk	Percentage of total solids	Percentage of fat	Total solids	Fat	Products per 100 pounds of dry matter: In entire ration: Milk	In entire ration: Total solids	In entire ration: Fat	In experimental feed: Milk	In experimental feed: Total solids	In experimental feed: Fat
Stella, uniform feeding on No. 4 ration..........	III	+ 1	— 4	— 4	+ 2	+ 6	— 3	+ 2	— 5	— 4	+ 1	— 1	+ 1	+ 6
Serena, period III, No. 3; II and IV, No. 4.........	III	+ 5	+ 4	+ 3	— 1	— 2	+ 2	+ 1	— 2	— 3	— 4	— 1	— 2	— 3
Results (±) of increase in ration as measured by Stella's record in comparison with Serena's..		+ 4	+ 8	+ 7	— 3	— 8	+ 5	— 1	+ 3	+ 1	— 5	0	— 3	— 9

[1] For further explanation of this phrase and of the meaning of the figures, see note on page 225 and explanatory note on table VII at the end of the appendix.

The following explanations may serve to make this table and its meaning more clear. The cows Stella and Serena, at the opening of the trials in December, gave promise of making much the same amounts of milk and butter, and of making milk of essentially uniform character during the next six months, provided they were similarly treated and fed. Stella was thus handled, being fed a uniform grain ration (No. 4) for 25 weeks. Serena, however, was not, since she alternated from the No. 3 to the No. 4 ration and back again. In the third period Stella made four percent less milk than she did on the average in the second and fourth periods of the unchanged ration. Serena made 3 percent more at the same time, due perhaps to her changed grain ration. It is assumed that her milk flow, like that of her mate's, would have decreased 4 percent had she, like her, been kept on the unchanged diet; that the same influences that caused Stella to shrink 4 percent in her milk flow would have brought about a similar change with Serena; hence her positive 3 percent gain is equivalent to a 4 + 3 or 7 percent gain, in that being fed No. 3 she was prevented from making a 4 percent shrinkage and in addition made a 3 percent gain. Hence +7 (or 7 percent of the total which equals 100) is the measure, in this particular case, of the effect of the changed ration on the milk flow. All the other items, the quality of the milk, the pounds of total solids and fat, and the same proportioned to the unit of dry matter, are similarly calculated. These plus and minus changes, gains and losses, as a result of varying rations, are the measures of the worth of the two rations by the combined method of continuity and alternation.

These comparisons can only be made when the cow alternately fed varying rations eats the same one as her mate in the first and last period under comparison and the other ration in the intermediate period. This limits the number of observations to, at best, two for each couple and, in the majority of cases, to but one. Thirty-nine comparisons only can be made, 16 in the trials of varying qualities and the remainder in those of varying qualities of grain rations.

Now the question arises, how do these nearly two score results arrived at by the combined continuous-alternating method, compare with those obtained by the alternation system? The data secured by the latter method are given at sundry points in connection with the previous article. The following table shows them condensed and compared with those derived in the manner just indicated by the combined system. The horizontal lines marked "differences" serve to show what divergences occur.

Reference number	Method employed	Changes in rations	Couples used	Number of observations or records	Total dry matter eaten	Dry matter in grain feed	Quantity of milk	Total solids, percent	Fat, percent	Quantity of total solids	Quantity of fat	Products per 100 pounds of dry matter: In total ration: Milk	In total ration: Total solids	In total ration: Fat	In experimental feed: Milk	In experimental feed: Total solids	In experimental feed: Fat
	Cont.-alter.	m. vl.	1, 2	6	-23		-16	- 3	- 4	-19	-20	+ 8	+ 6	+ 4			
I	Alternation	m. vl.	5, 6	3	-23		-16	- 2	- 4	-18	-20	+ 8	+ 5	+ 4			
	Differences				0		0	1	0	1	0	0	1	0			
	Cont.-alter.	vl. m.	13, 14	3	+26		+15	+ 3	+ 5	+17	+20	-10	- 7	- 5			
II	Alternation	vl. m.		3	+25		+16	+ 3	+ 4	+19	+21	- 7	- 4	- 3			
	Differences				1		1	0	1	2	1	3	3	2			
	Cont.-alter.	vl. l.	11, 12	3	+ 7		+ 9	+ 1	+ 3	+10	+12	+ 2	+ 3	+ 5			
III	Alternation	vl. l.		3	+ 6		+11	+ 1	+ 2	+12	+13	+ 4	+ 6	+ 6			
	Differences				1		2	0	1	2	1	2	3	1			
	Cont.-alter.	l. vl.	15, 16	3	- 9		-15	0	- 1	-15	-15	- 7	- 6	- 7			
IV	Alternation	l. vl.		3	- 8		- 6	0	- 2	- 6	- 8	+ 2	+ 2	+ 1			
	Differences				1		9	0	1	9	7	9	8	8			
	Cont.-alter.	vl. l.	17	1	+13		+ 8	+ 3	+ 9	+11	+18	- 5	- 2	+ 8			
V	Alternation	vl. l.		1	+10		+ 8	+ 3	+ 7	+12	+16	- 2	+ 1	+ 6			
	Differences				3		0	0	2	1	2	3	3	2			
	Cont.-alter.	4-3	29, 30	3	+ 7	+20	+ 9	- 1	- 4	+ 8	+ 6	+ 1	+ 1	- 2	- 9	-10	-13
VI	Alternation	4-3	31	3	+ 7	+16	+ 5	0	0	+ 5	+ 6	- 2	- 2	- 2	-10	- 9	- 9
	Differences				0	4	4	1	4	3	0	3	3	0	1	1	4
	Cont.-alter.	3-4	26, 28	2	+ 1	+ 4	+ 5	0	+ 1	+ 5	+ 6	+ 4	+ 4	+ 5	+ 2	+ 2	+ 3
VII	Alternation	3-4		1	- 3	+ 1	+ 3	+ 1	+ 2	+ 4	+ 5	+ 6	+ 7	+ 9	+ 3	+ 4	+ 5
	Differences				4	3	2	1	1	1	1	2	3	4	1	2	2
	Cont.-alter.	3-2	25	1	+ 7	+22	- 5	+ 1	0	- 4	- 4	-11	-11	-11	-26	-25	-23
VIII	Alternation	3-2		1	+ 2	+15	- 3	0	- 3	- 3	- 5	- 4	- 5	- 7	-16	-16	-17
	Differences				5	7	2	1	3	1	1	7	6	4	10	9	6
	Cont.-alter.	2-3	3, 7	4	+ 2	+ 5	+ 5	0	+ 2	+ 5	+ 7	+ 4	+ 5	+ 6	- 1	- 1	+ 2
IX	Alternation	2-3	9, 10	3	+ 2	- 2	+ 5	+ 1	+ 3	+ 6	+ 8	+ 4	+ 5	+ 7	+ 9	+ 9	+11
	Differences				0	7	0	1	1	1	1	0	0	1	10	10	9
	Cont.-alter.	1-3	19, 21	2	0	+ 1	+ 3	+ 1	+ 3	+ 5	+ 5	+ 3	+ 4	+ 6	+ 2	+ 4	+ 5
X	Alternation	1-3		2	- 2	+ 1	- 1	+ 1	+ 4	+ 1	+ 3	0	+ 1	+ 4	- 2	- 1	+ 2
	Differences				2	0	4	0	1	4	2	3	3	2	4	5	3
	Cont.-alter.	3-1	27	1	+ 2	- 2	- 1	0	- 3	- 2	- 4	- 4	- 6	- 6	+ 1	+ 1	- 2
XI	Alternation	3-1		1	- 1	- 2	- 3	+ 1	0	- 2	- 3	- 2	- 2	- 2	- 1	+ 1	-11
	Differences				3	0	2	1	3	0	1	2	4	4	2	0	1
	Cont.-alter.	2-1	4,8	4	+ 2	+ 1	0	+ 2	+ 3	+ 2	+ 3	- 2	- 1	+ 1	- 1	+ 1	+ 2
XII	Alternation	2-1		3	+ 2	+ 2	+ 1	0	0	+ 1	+ 1	- 2	- 2	- 1	- 1	- 2	- 1
	Differences				0	1	1	2	3	1	2	0	1	2	0	3	3
	Cont.-alter.	1-2	18, 20	5	- 1	- 3	+ 1	0	0	+ 1	+ 1	+ 3	+ 3	+ 3	+ 3	+ 3	+ 3
XIII	Alternation	1-2	22, 23	3	- 3	- 3	- 1	0	+ 1	+ 1	0	+ 2	+ 2	+ 3	+ 1	+ 2	+ 2
	Differences		24		2	0	2	0	1	0	1	1	1	0	2	1	1
	Cont.-alter.	Po-Si	32	1	- 5		-11	- 5	- 9	-18	-23	- 6	-11	-18			
XIV	Alternation	Po-Si		7	- 3		0	0	0	0	0	+ 3	+ 3	+ 3			
	Differences				2		11	5	9	18	23	9	14	21			
	Cont.-alter.	Si-Po	33	1	+ 4		+10	0	0	+11	+11	+ 6	+ 7	+ 7			
XV	Alternation	Si-Po		5	+ 8		+ 9	+ 1	+ 2	+ 9	+10	+ 1	+ 1	+ 3			
	Differences				4		1	1	2	2	1	5	6	4			

There were fifteen comparisons made, carrying 167 "difference" figures. Naturally zeros and ones are all that can be desired; twos are quite satisfactory and indicate fair agreement; threes are somewhat wide, while fours and larger figures mean serious differences. All figures larger than 3 are shown in black face.

There appear 62 "differences" which are threes or larger, including 42 which are fours or larger. Expressing the relations by way of fractions:

Three-eighths of the entire number are threes and larger.

One-fourth of the entire number are fours or larger.

Nine of the 15 sets show wide discrepancies, being Nos. IV, VI, VII, VIII, IX, X, XI, XIV, and XV. Two of them show only two fours apiece and two more, fours with a single five. Only five of the fifteen comparisons are really very bad.

Let us analyze the data, getting the small sinners out of the way first.

VII. *2 fours.* One of these is caused by fractions, which, if carried out, would make the result about 3.5. The other is caused by the low eating of total dry matter by certain cows in period IV.

XI. *2 fours.* A single record. The slightly better milk given by the even fed cow Rosel on period IV, when she ate less total dry matter than in the other periods, served to swell the figures and to carry them just over the line.

VI *4 fours.* Sonoma and Monterey did not relish clear distillers' grains (No. 4) and left considerable amounts uneaten which naturally made some results irregular. Stella, the only cow continuously fed this ration whose record is available, made an odd record. She ate very uniformly throughout the trials, but her milk yields in successive periods show a curious sag. I, 642, II, 511, III, 479, IV, 492, V, 540. Her third period record compared with the average of the second and fourth are used against that of three other cows. Stella shrank 4 percent in milk yield, at the same time that both Serena and Monterey increased 3 percent, and Sonoma 9 percent in the milk flows. Stella's fat percentage went skywards at the same time. These divergent results are added, making a calculated 9 percent gain in milk flow and, of course, affecting the dependent data accordingly.

This episode affords a good illustration of the way in which a single cow's idiosyncracy may affect several records.

X. *3 fours and 1 five.* Rosemary's (even fed) high milk flow in her initial period and sharp fall in the second one is in part at fault here. Primrose made less milk on No. 3 than on No. 1, while Golden-

rod did the reverse. These variations, more particularly the first, are the cause of all four discrepancies.

Now for the five very bad exhibitions, Nos. IV, VIII, IX, XIV, and XV.

IV. Flora was the only cow continuously fed on one ration whose record is available for use in this comparison. She made a rather odd record, the exact reverse of Stella's, cited above. She gave on continuous and very even feeding, the following yields in successive periods: I, 373, II, 401, III, 424, IV, 376, V, 226.

The fifth period is useless in this connection. The high third period record affects the whole outcome, when it is used in the combined method, and is responsible for all the high figures occuring in the difference column.

VIII. This record is that of a single couple, Janice, fed No. 3 in period III and V and No. 2 in IV and Vivian continuously fed No. 3. The latter in the fourth period ate 5 percent less dry matter in the total ration and 7 percent less in her experimental feed than in the periods III and V; yet she made, notwithstanding, 2 percent more milk. This eccentricity is accountable for the entire lot of wide figures.

IX. The divergencies in this instance are due to the fact that Janice left considerable amounts of No. 3 feed uneaten. This affected the figures in the second column and the three at the extreme right. No cow could be found which was continuously fed No. 2, whose record was in the least comparable with hers. Max Belle and Ursula gave too much, Katrina and Beautina too little milk. Hence Janice's record modifies the data on one side and does not appear on the other side at all; and hence the discrepancies. If Janice's record be matched with that of a hypothetical animal, the average of the four just named, a good match is attained and the continuous-alternation data are so modified that the 7, 10, 10 and 9 become 3, 7, 7 and 6. Thus somewhat better showing is made though it is still a bad one.

XIV and XV. These are both of them single comparisons matched with large numbers. Six cows which contributed nothing to the combined data build up the alternation side of the comparison. Then, too, the cow Eva, continuously fed pomace, ate 5 percent less dry matter, yet made 5 percent more milk and 7 percent better (fat percentage) milk in the second period than she did in the average of the others. This naturally warps the result in one period. Moreover, Minta Bella, continuously fed silage in one period, made 3 percent more milk on 2 percent less feed, while Mermaid made 4 percent more

than an average gain on pomace over corn silage. Reasons enough for abnormalities!

What about the general outcome?

Six sets (I, II, III, V, XII, and XIII) or 40 percent of the entire number of comparisons are good ones; four more (VI, VII, X, and XI) are indifferent, neither good nor very bad; and five (IV, VIII, IX, XIV, and XV) are bad.

How does this compare with the results of previous years?

1900-01 4 comparisons, 2-3 good, 1-3 bad.

1901-1902 6 comparisons, 1-2 good, 1-6 indifferent, 1-3 bad.

1902-03 15 comparisons, 2-5 good, 1-4 indifferent, 1-3 bad.

The results of the comparisons last year were so unfavorable that it was deemed wise this year to elongate the period length to five weeks on the chance that this might improve the outcome. This desideratum does not, however, at first sight seem to have been attained. It is worth while, however, to look into the data a little further. There does not seem to be much relation between the closeness of the matches and the outcome. The matches of the five bad sets were in one case good, in three fair and in but one bad; whereas in the six good sets they were good once, fair four times and bad but once. There does, however, seem to be a *close relationship between the number of available observations and the character of the outcome.* There were nine sets which resulted poorly. In five of these nine, on one side or the other of the comparison, but a single observation was available; and in one other, only two. In other words, two-thirds of the failures are traceable to paucity of data, to the effect of idiosyncracies of single animals. Nay, further than this, in two of the other three cases the eccentricities of single cows (Flora, Stella) were mainly at fault. The outcome of only one of the six good sets was based on a single observation.

The vagaries this year, as in the past two years, seem to be located for the most part in the data afforded by the combined system. As has hitherto been shown, this means of measurement is open to many errors. The number of observations is apt to be curtailed, the individualties of two cows have to be dealt with instead of that of one, while any error in the record of one affects that of both. The results obtained by its use need close scrutiny before they are used as a basis for deduction. The apologies made in the last report for the freaks of Fresno, Flora and Edith, and in this issue in behalf of Flora, Stella and others, bear testimony of this fact. To be sure, the alternation data is often not above suspicion. In the present

instance Janice was fed in alternation; but her record did more mischief and was less readily discounted when linked with the data derived from the records of other cows than when it was used in simple alternation.

The outcome of three years' trials have, on the whole, served to strengthen the writer's belief that alternation is the safer of the two methods. Last year's statement seems to need no qualification. "A deduction based on agreeing data obtained by both methods of trial is much strengthened over that drawn from the results afforded by either alone; but in the event of a lack of substantial unanimity, if inexplicable, the writer, with his faith in the credibility of the outcome somewhat shaken, would feel inclined to trust the data arrived at by alternation rather than that furnished by the combined method, providing the feeding periods were four, five or six weeks long, and the choice of cows satisfactory."

While it does not seem likely that material change in this position will result from future trials, it is expected to continue this comparison for some years to come with a view of accumulating further data. Then, too, as has been just remarked, the regular feeding trials are the better therefor, since the attainment of agreeing results by radically different methods of experimentation lends weight to the deductions which may be drawn therefrom.

RECORD OF THE STATION HERD FOR 1902-1903

The doings of the Station herd for the past year (Nov. 1, 1902 to Oct. 31, 1903) appear here, partly as a matter of record for future reference and partly because of the good effect which its perusal may exert on dairymen. It is hoped at the end of the next record year, when a decade of data taking will have been completed, some collection and digestion of the accumulated mass of figures may be made.

The current year's record is the poorest one made since the establishment of the Station herd. There are several reasons for this outcome.

1. The extreme drought of the spring of 1903 and the short pasture resulting therefrom.
2. The immature silage due to the wet summer of 1902.
3. The use of nearly a third of the cows in feeding trials which involved very light grain feeding—2 to 4 pounds daily.

In no case were the cows forced, and as has been remarked, they were often underfed. It is no wonder that the record is a low one.

The records shown on the next few pages include for each cow

the production of milk, total solids, fat and butter, the cost of the food eaten to the 100 pounds of milk and to the pound of fat and butter, the total cost of the food eaten, of the purchased grain, the net proceeds from butter sales—at the average price actually received during the year for butter—and the value of the fertilizing ingredients in the fodders and feed eaten.

The average production of milk and of butter for the entire herd during the last eleven years has been satisfactory and fairly uniform. The butter productions have been as follows: 1892, 335 pounds; 1893, 330 pounds; 1894, no record; 1895, 325 pounds; 1896, 324 pounds; 1897, 338 pounds; 1898, 313 pounds; 1899, 320 pounds; 1900, 357 pounds; 1901, 343 pounds; 1902, 308 pounds; 1903, 294 pounds. The herd of 1892-93 contained about twenty cows and was slaughtered early in 1894 because of tuberculosis. The animals included in the present herd were bought at various times, from 1894 to 1903.

There were 70 cows in the herd within the limits of the record year,[1] but only 48 were members throughout the year. Some of the cows not figuring in the main tabulations were heifers with their first calves; some were sold for beef and some were purchased during the year. The records of the cows which did not finish their record year have been kept as carefully as have those of the animals which completed the year. These broken records have not the value that pertains to complete data, yet, inasmuch as several of these cows figured in past records and many of them will figure in future ones, it is thought best to publish the figures. They follow the main tabulations. The cows whose names are italicized in the tables are registered Ayrshires, those in black face are registered Jerseys. All others are high grade Jerseys. Most of the animals have higher records in past years than those given in the present tabulations.

The remarks on this page and four pages further on are explanatory of the record tables on the next four pages.

"*Pounds of milk*" are obtained by weighing each milking of each cow throughout the year.

"*Percent of fat*" is obtained by averaging by cross-division. Composite samples—eight or nine milkings each—are taken of the milk of each cow bi-monthly throughout the year and constantly while on feeding experiment.

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[1] Nov. 1 to Oct. 31 constitutes a record year.

RECORD OF THE HERD OF THE VERMONT AGRICULTURAL EXPERIMENT STATION FOR THE YEAR FROM NOV. 1, 1902, TO OCT. 31, 1903

Name of Cow	Calved	Served	Days in milk	Milk	Total solids	Fat	Total solids	Fat	Butter
				lbs.	%	%	lbs.	lbs.	lbs.
Acme 5th, 10342 A. R.	March 25	Jan. 3	250	4221	11.90	3.75	502.4	158.5	184.9
Adelaide	April 13	Dec. 16	254	5363	13.98	4.88	749.8	261.6	305.2
Atalanta, 10777 A. R.	Aug. 1	Feb. 7	327	5519	12.32	3.68	679.9	203.0	236.8
BEAUTINA, 85928 A. J. C. C.	Feb. 11	Sept. 6	323	5236	13.98	4.84	732.1	253.3	295.5
Ceres	Jan. 6	March 20	314	5888	14.67	5.24	862.8	308.5	359.9
Dahlia	May 13	Aug. 1	365	4349	15.17	5.70	659.9	247.8	289.1
Dorothy	Feb. 14	July 4	311	4384	14.50	4.98	635.7	218.3	254.7
Edith	Jan. 25	July 19	323	6527	14.10	4.96	920.3	323.7	377.6
Elsa		Nov. 30	321	5273	14.31	5.11	754.5	269.4	314.3
Eunice	Dec. 3	March 11	327	6330	14.18	4.80	896.3	303.4	354.0
Eva	Jan. 1	Sept. 2	333	4324	16.34	6.41	706.6	277.2	323.4
Flora	July 29	Dec. 27	268	4122	13.97	4.86	575.8	195.2	227.7
Fresno	Dec. 2	Feb. 6	272	2468	14.33	4.82	353.7	118.9	138.7
Goldenrod	July 31	March 24	329	4413	16.90	6.71	745.9	296.3	345.7
Haidee			308	5498	14.92	5.34	820.0	298.4	342.8
Hallowe'en	April 30	March 14	365	4076	15.08	5.65	614.5	230.3	268.7
Inez	Nov. 23	May 4	334	5642	14.92	5.54	841.9	312.4	364.5
Janice		Jan. 10	365	4448	14.97	5.20	665.9	231.2	269.7
Jersey Lily 2nd			280	3958	15.62	5.86	618.4	231.8	270.4
Juanita	Aug. —	Oct. 29	317	4495	15.44	5.66	694.1	254.2	296.6
Kimberley	Feb. 6	April 12	310	4625	13.07	4.05	604.2	187.5	218.8
LADY PERUSIA, 123228 A. J. C. C.	Nov. 23	May 4	340	6188	15.20	5.78	941.0	357.5	417.1
Lavender	Farrow	Oct. 26	271	3434	14.96	5.60	513.6	192.2	224.2
Lorna Doone	Feb. 24	Nov. 18	249	3099	13.38	4.20	414.5	130.3	152.0
Lucerne	Oct. 11	Jan. 31	309	4680	15.26	5.61	714.2	262.4	306.1
Maid Marian	July 2	March 21	365	5084	14.04	4.87	713.9	247.7	289.0
MAX BELLE, 108996 A. J. C. C.	Nov. 4	July 7	357	5548	15.23	5.50	845.0	305.3	356.2
Max Ella			325	4129	14.17	4.82	586.0	199.1	232.3
Mermaid	Feb. 11	Sept. 4	304	4571	16.16	6.30	738.7	288.2	336.2
MINTA BELLA, 85578 A. J. C. C.	June 7	Aug. 3	321	6200	15.08	5.66	934.8	351.0	409.5
Mona	*June 7	April 16	290	2991	14.79	5.40	442.6	161.4	188.3
Nancy B., 9581 A. R.	April 24	Oct. 25	317	5610	12.61	3.81	707.5	213.8	249.4
Orpha	April 16	Oct. 21	307	5866	13.49	4.24	791.1	248.8	290.3
Pomona	Dec. 9	March 16	325	4705	15.11	5.46	711.0	256.8	299.6
Primrose	Jan. 7		303	4584	13.65	4.61	625.9	211.5	246.7
Rosel	June 7	Nov. 19	327	6129	14.48	4.98	899.0	305.6	356.5
Rosemary	Jan. 4	April 4	256	4661	13.96	4.66	650.7	217.0	253.2
Santa Clara	May 16	Oct. 20	247	5382	15.71	5.85	845.7	315.0	367.5
Santa Rosa	July 16	Nov. 6	327	5368	14.23	4.64	694.8	226.4	264.1
Serena	Nov. 20	May 9	344	6221	14.13	4.77	879.0	297.0	346.5
Sonoma	Jan. 10	April 5	335	6081	14.68	5.16	892.3	313.6	365.9
Star Bright	*Sept. 21	July 6	365	5156	15.68	5.88	808.7	303.2	353.7
Stella	Nov. 28	March 14	296	5938	14.14	4.70	839.6	279.0	325.5
Surprise	June 13	Feb. 18	309	3533	15.02	5.31	530.8	187.6	218.9
VERMONT UNA	Dec. 12	Aug. 3	310	4489	15.16	5.69	680.2	255.3	297.9
Ursula	Aug. —	Dec. 2	324	5821	14.92	5.27	863.2	306.9	358.1
Vivian		Nov. 16	350	5358	13.90	4.63	745.0	247.9	289.2
Yuba	July 29	Jan. 14	297	4194	15.25	5.58	639.5	233.9	272.9
Averages				4920		5.13	714.2	251.8	293.8

HERD RECORD—Continued

Name of Cow	Total cost of food	Total cost of purchased grain	Cost of food for 100 pounds of milk	Cost of food for 1 pound of fat	Cost of food for 1 pound of butter	Proceeds from butter sales at 30 cents per pound	Value of fertilizing ingredients
	$	$	cts.	cts.	cts.	$	$
Acme 5th	48.24	20.31	114.3	30.4	26.1	55.47	28.60
Adelaide	50.75	18.21	94.6	19.4	16.6	91.55	30.27
Atalanta	43.41	14.34	78.6	21.4	18.3	71.04	24.81
Beautina	54.04	27.18	103.2	21.3	18.3	88.64	31.64
Ceres	51.33	22.45	87.2	16.6	14.3	107.97	30.34
Dahlia	56.84	28,47	130.7	22.9	19.7	86.72	33.76
Dorothy	51.09	22.18	116.5	23.4	20.1	76.41	31.05
Edith	54.06	24.38	82.8	16.7	14.3	113.27	32.55
Elsa	45.72	13.11	86.7	17.0	14.5	94.29	27.01
Eunice	52.81	20.88	83.6	17.4	14.9	106.20	30.61
Eva	48.62	23.26	112.4	17.5	15.0	97.02	29.96
Flora	39.45	12.68	95.7	20.2	17.3	68.31	23.25
Fresno	37.99	9.49	153.9	32.0	27.4	41.61	21.03
Goldenrod	61.21	28.56	138.7	20.7	17.7	103.70	37.11
Haidee	57.41	25.15	104.4	19.6	16.8	102.68	34.48
Hallowe'en	58.99	27.24	144.7	25.6	22.0	80.60	34.79
Inez	48.10	16.08	85.2	15.4	13.2	109.33	26.98
Janice	55.87	27.18	125.6	24.2	20.7	80.90	33.11
Jersey Lily 2nd	47.84	19.03	120.9	20.6	17.7	81.12	27.99
Juanita	51.07	23.29	113.6	20.1	17.2	88.97	30.50
Kimberley	51.63	21.52	111.6	27.5	23.6	65.64	30.81
Lady Perusia	51.51	19.43	83.2	14.4	12.4	125.12	29.40
Lavender	47.39	21.70	133.0	24.7	21.1	67.26	28.54
Lorna Doone	38.10	15.63	122.9	29.2	25.1	45.60	22.20
Lucerne	44.19	16.31	94.4	16.8	14.4	91.82	25.78
Maid Marian	43.01	17.82	84.6	17.4	14.9	86.70	23.89
Max Belle	57.86	26.75	104.3	19.0	16.2	106.85	34.71
Max Ella	52.51	23.75	127.2	26.4	22.6	69.68	31.29
Mermaid	49.12	24.21	107.5	17.0	14.6	100.86	30.04
Minta Bella	52.18	23.66	84.1	14.9	12.7	122.83	30.93
Mona	49.63	24.54	165.9	30.8	26.4	56.49	29.40
Nancy B.	53.24	25.73	94.9	24.9	21.3	74.82	31.13
Orpha	55.80	24.23	95.1	22.4	19.2	87.08	32.28
Pomona	48.45	18.41	103.0	18.9	16.2	89.87	28.39
Primrose	55.89	24.27	121.9	26.4	22.7	74.00	33.59
Rosel	57.96	26.64	94.6	19.0	16.3	106.93	35.09
Rosemary	49.63	20.01	106.5	22.9	19.6	75.96	30.25
Santa Clara	51.41	25.19	95.5	16.3	14.0	110.23	32.45
Santa Rosa	50.56	23.16	103.5	22.3	19.1	79.22	29.90
Serena	60.29	29.86	96.9	20.3	17.4	103.94	35.56
Sonoma	56.62	26.72	93.1	18.1	15.5	109.76	33.41
Star Bright	58.25	28.39	113.0	19.2	16.5	106.10	35.30
Stella	56.24	25.34	94.7	20.2	17.3	97.64	32.62
Surprise	39.39	17.22	111.5	21.0	18.0	65.66	21.95
Vermont Una	44,57	19.42	99.3	17.5	15.0	89.36	25.70
Ursula	55.72	23.93	95.7	18.2	15.6	107.41	34.26
Vivian	54.58	27.14	101.9	22.0	18.9	86.75	32.58
Yuba	47.57	22.37	113.4	20.3	17.4	81.86	28.63
Averages	51.00	22.22	106.9	21.1	18.0	88.15	30.23

RECORD OF THE HERD OF THE VERMONT AGRICULTURAL EXPERIMENT STATION FOR THE YEAR FROM NOV. 1, 1902, TO OCT. 31, 1903

Name of Cow	Calved	Served	Days in milk	Milk	Total solids	Fat	Total solids	Fat	Butter
				lbs	%	%	lbs	lbs	lbs.
Alta	March	Oct. 28	191	3358	14.15	4.94	475.0	165.8	193.4
Bertha	April 9	Jan. 8	180	1373	15.48	5.77	212.5	79.2	92.4
Buttercup	....	....	8	62	17.76	7.60	11.1	4.7	5.5
Clare	....	....	17	168	14.17	5.00	23.8	8.4	9.8
Constance	March	Nov. 7	191	3407	14.15	5.00	481.9	170.5	198.9
Eleanor	March	Jan. 12	191	3246	14.82	5.29	480.9	171.7	200.3
Idarella	April 13	Farrow	89	752	14.58	5.20	109.6	39.1	45.6
Judith	March	July 23	191	2987	15.05	5.66	449.7	169.0	197.2
Katrina	Sept. 27	March 18	192	1588	15.32	5.59	243.3	88.8	103.6
Lady Ullan	Feb. 17	June 14	253	3407	12.90	3.93	439.4	133.9	156.2
Linnet	Jan. 28	....	275	3561	14.10	4.87	502.0	173.5	202.4
Lizzie Hexham	March	Sept. 20	191	3493	13.73	4.40	479.6	153.8	179.4
Monterey	May 26	Oct. 29	182	3120	13.79	4.67	430.3	145.8	170.1
MURIEL (Vt.)	Dec. 21	Nov. 14	315	3802	14.88	5.42	566.1	205.8	24.18
Naomi	Dec. 25	April 23	182	2812	14.76	4.88	415.1	137.2	160.1
Nora	April 7	....	60	537	14.06	4.58	75.5	24.6	28.7
Powella	March 13	Farrow	206	1662	16.67	6.86	277.0	114.0	133.0
Pretoria	Sept. 29	Feb. 15	206	3696	13.62	4.38	503.5	161.8	141.8
Queenie	Feb. 27	Aug. 14	245	2847	14.43	4.98	410.9	141.8	165.4
Stephanie	March	Nov. 13	191	3715	13.59	4.37	504.6	162.3	189.3
Sylvia	....	....	7	93	14.62	5.05	13.6	4.7	5.5
Yemassee	March	Dec. 8	191	3351	13.80	4.66	462.6	156.2	182.2

Name of Cow	Total cost of food	Total cost of purchased grain	Cost of food for 100 pounds of milk	Cost of food for 1 pound of fat	Cost of food for 1 pound of butter	Proceeds from butter sales at 30 cents per pound	Value of fertilizing ingredients
	$	$	cts	cts	cts	$	$
Alta	28.22	14.98	84.0	17.0	14.6	58.01	14.16
Bertha	31.63	18.48	230.4	39.9	34.2	27.72	21.96
Buttercup	1.85	0.84	298.4	39.4	33.6	1.65	1.28
Clare	3.66	1.79	217.9	43.6	37.3	2.94	9.16
Constance	28.22	15.15	82.8	16.6	14.2	59.66	14.24
Eleanor	28.58	15.07	88.1	16.6	14.3	60.09	14.45
Fairie	3.24	1.50	.....	....	....	.....	3.21
Idarella	15.18	9.11	201.9	38.8	33.3	13.68	11.63
Judith	28.06	14.74	93.9	16.6	14.2	59.15	14.11
Katrina	21.56	8.93	135.8	24.3	20.8	31.08	15.52
Lady Ullan	33.61	17.00	98.6	25.1	21.5	46.86	18.30
Linnet	29.73	12.26	83.5	17.1	14.7	60.71	15.60
Lizzie Hexham	28.93	15.48	82.8	18.8	16.1	53.81	15.91
Monterey	33.48	16.52	107.3	23.0	19.7	51.03	22.45
MURIEL (Vt.)	36.45	16.23	95.9	17.7	15.1	72.54	19.77
Naomi	28.63	16.48	101.8	20.9	17.9	48.03	20.67
Nora	10.88	2.79	202.6	44.2	37.9	8.61	9.23
Powella	37.61	18.48	226.3	33.0	28.3	39.90	22.03
Pretoria	31.41	12.35	85.0	19.4	22.2	42.54	21.22
Queenie	26.03	14.79	91.4	18.4	15.7	49.62	12.83
Stephanie	29.85	16.73	80.4	18.4	15.8	56.78	15.01
Sylvia	1.78	0.84	191.4	37.9	32.4	1.65	1.28
Yemassee	27.96	15.51	83.4	17.9	15.3	54.66	13.71

"*Pounds of butter*" are obtained by adding the usual factor *one-sixth* to the pounds of fat. This is equivalent to a "surplus" of 16.7 percent. The conditions of our work (much sampling, varying methods of handling, frequent handling of relatively small quantities, etc.) are such that it is doubtful whether our average "surplus" is often thus high. Much cream and some milk are sold, and large amounts are taken as samples; hence our exact make *all as butter* cannot be stated. Conservative estimates of the butter values of these sold and sampled products, added to the known butter sales, when compared with calculations using the one-sixth factor, have in years past agreed within a narrow margin and show a surplus of 12 to 14 percent. It is manifestly unfair to charge against the cows these losses, which are to a considerable extent caused by the peculiar nature of our work and which do not obtain in ordinary dairy management.

"*Cost of food*" is reckoned from prices paid for grain, while hay is rated at $10, silage, soiling crops, etc., at $3, pasturage for the season at $5 per animal.

The average cost of food for 100 pounds of milk and for a pound of butter as stated in the table is obtained by dividing the total by 48, thus giving each cow the same value in the average, be her record good, bad or indifferent. *As a herd* the average cost of food for 100 pounds of *herd* milk and for a pound of butter were considerably less than is stated.

The figures showing "cost of 100 pounds of milk" and "cost of one pound of butter" include only the cost of food as laid down in barn ready for feeding. They do not include cost of feeding, caring for cows, making and marketing butter, depreciation of plant, interest on investment, etc. It is to be remarked, however, on the other hand, that many items other than those cited may be considered, in some degree at least, an offset against these expenditures and charges. Thus for example, it should be noted:

1. That "roughages" are rated as figures sufficiently liberal to more than cover the cost of raising and harvesting in average seasons.

2. That the manurial constituents in the food fed at the barn are worth nearly half of its rated cost if these are reckoned at market prices for the same plant food of nearly if not quite the same availability in the form of commercial fertilizers. There are also considerable amounts of plant food in the pasture grass eaten and thus transferred to the barn, not included in the schedule.

3. That the manurial constituents in the purchased grain were worth, when similarly rated, about three-fifths of its market price.

4. That a ton of butter removes less than a half dollar's worth of plant food from the farm.

5. That the increase of the herd and the sales of calves and fat cows are further items not considered above.

6. That the skimmilk and buttermilk from the 48 cows, at 20 cents per hundred (an absurdly low price as pork sells to-day), was worth in the vicinity of $450.00.

The herd on the whole made the most butter in 1899-1900, and made it most cheaply in 1895-96. Yet owing to the selling prices for butter, the financial showing of the past four years is better than that of former years. These points are brought out in the following table:

Year	No. of cows	Pounds of milk	Pounds of butter	Cost of feed	Proceeds for butter	Value of butter over cost for feed
1903	48	4910	294	$51.00	$88.15	$37.15
1902	49	5166	308	49.18	85.38	36.20
1901	47	5814	344	49.97	94.56	44.59
1900	45	5935	357	52.43	97.15	44.72
1899	47	5462	320	45.17	83.18	38.01
1898	42	5296	313	46.40	80.58	34.18
1897	29	5730	338	47.45	82.04	34.59
1896	37	5431	324	42.00	74.51	32.51
1895	33	5633	325	50.06	76.40	26.34

The following tables show extremes of quantity, quality, cost of production, etc., during the year:

EXTREMES OF PRODUCTION

	Lowest amount for any cow		Highest amount for any cow	
Pounds of milk	2468	Fresno	6527	Edith
Percent of total solids	11.90	Acme	16.90	Goldenrod
Percent of fat	3.68	Atalanta	6.71	"
Pounds of total solids	353.7	Fresno	941.0	Lady Perusia
Pounds of fat	118.9	"	357.5	"
Pounds of butter	138.7	"	417.1	"
Cost of feed	$37.99	"	$61.21	Goldenrod
Cost of grain	$9.49	"	$29.86	Serena
Cost of 100 pounds of milk	78.6¢	Atalanta	158.9¢	Fresno
Cost of 1 pound of fat	14.4¢	Lady Perusia	32.0¢	"
Cost of 1 pound of butter	12.4¢	"	27.4¢	"
Value of butter at actual selling price	$41.61	Fresno	$125.12	Lady Perusia
Value of fertilizing ingredients in food	$21.08	"	$37.11	Goldenrod

The usual wide extremes are found. The herd, as a whole, as had been already noted, did poorer work than at any time in ten years. Almost every cow fell off more or less and the average production of milk was lower than ever before.

It is interesting to note the reason for the record of the tail-ender, Fresno. This cow made 307 pounds of butter during her first record year in milk. She is of good breeding and of good dairy conformation. She was fed for twenty-five weeks during the past year continuously a daily grain ration of but two pounds. During the entire year she ate less than ten dollars' worth of grain, but little more than 40 percent of what the average cow of the herd received, and but little more than a third of what the better-fed cows ate. She made 139 pounds of butter instead of 307. In her first year she ate $18.90 worth of grain, almost exactly double the cost of her 1903 grain ration; but she made more than twice as much butter. It cost—for food—27.4 cents a pound to make the butter one year, but 15.9 cents a pound the other year. The receipts for butter were $41.61 one year and $85.24 the other. She went dry quickly and stayed dry long; and who can blame her?

There are many Fresnos in New England dairies; cows which are capable of doing good work, but are given no chance. Not every cow which makes but little butter responds as Fresno does when well fed. Some are not built that way; but lots of them would do so. Give such cows a chance.

The following table shows the feeding record of each cow which was a member of the herd within the record year. All of the cows were out to pasture for about five and one-half months, but were housed over night. They were fed twice daily the year around, grained during the summer to some extent, watered in winter twice a day, and turned out in the winter for from 20 to 40 minutes daily except in extreme weather. The station herd is used in feeding experiments from December to June, during which time the cows are subjected to many changes in ration. In some cases materials may be fed which are distasteful, and, frequently, wasteful or ill-balanced rations are designedly used. These changes, necessitated by the conduct of feeding experiments, are obviously not conducive to maximum production. At no time was special effort made to select or to feed the most economical ration, or to force any cow to her utmost.

FEEDING RECORD

NAME	Hay	Silage	Apple pomace	Rowen*	Green hungarian	Wheat bran	Corn meal	Cottonseed meal	Linseed meal	Dried distillers' grains	Dried brewers' grains	Nutrene
Acme	3468	1696	1328	196		1292	329	298	13		23	12
Adelaide	4045	2681	1242	554	163	1175	387	174	13		23	12
Alta	484	2256		545	162	967	379	80	13		23	12
Atalanta	2696	6053	278	276	160	801	245	73	12	3	297	12
Beautina	2459	4575	275	560	164	1362	420	64	4	378	384	7
Bertha	2522	3598	277			562	44	44			776	
Buttercup	199		28			52	14	14				
Ceres	3496	3457	2419			1448	499	203	13		27	12
Clare	362		118			118	28	28				
Constance	523	1936		562	160	984	381	83	14	361	24	12
Dahlia	2586	5192	271	551	164	1578	396	188	99		22	12
Dorothy	3097	3705	1226	492	158	1350	367	161	93		192	12
Edith	3081	4278	678	560	155	1550	379	225	154		23	12
Eleanor	515	2255		557	163	984	374	83	14		24	12
Elsa	3231	6044	278	507	122	723	188	62	12	571	335	9
Eunice	2887	6585	128	559	163	942	283	38	12		22	11
Eva	2885	990	3837	557	164	1508	410	184	141			
Fairie	318		105			98	25	24				
Flora	2529	5130	278	314		632	98	71	11		481	11
Fresno	2820	6028	108	72		421	94	27	11	266	21	11
Goldenrod	3345	6099	278	336	163	1444	297	166	105	555	23	12
Haidee	3485	4435	1247	561	163	1608	450	209	129		23	12
Hallowe'en	3651	2524	1310	547	162	1759	557	298	13		23	12
Idarella	1186	1345	278			590	146	146				
Inez	2879	6681	98	561	164	884	326	28	12	234	22	11
Janice	2569	5450	276	553	162	1317	365	75	13	453	349	12
Jersey Lily 2nd	3159	3045	1781	561	162	1234	441	148	12		23	12
Juanita	2601	4761	266	548	162	1062	265	44		370	513	
Judith	495	2221		551	164	966	367	77	14		24	13
Katrina	1815	2960	224			376	32	31		2	501	
Kimberley	3269	3553	1794	556	163	1381	332	78	18	251	23	13
Lady Perusia	2906	6648	108	556	163	985	345	49	12	373	21	12
Lady Ullan	1058	2156	1213	542	163	1093	405	125	12		22	11
Lavender	2427	3940	278	549	164	1369	269	231	188			
Linnet	1201	2988		430	149	682	245	31		179	18	9
Lizzie Hexam	514	2247		555	162	1084	332	86	14		24	13
Lorna Doone	1985	3268	227	558	160	944	200	136	104		131	
Lucerne	2694	5807	278	122	40	851	207	74	13	3	506	12
Maid Marian	2732	2549	275	561	168	1011	322	72	12	5	366	10
Max Belle	2701	6625	258	557	163	1363	360	65	13	11	934	12
Max Ella	2960	4033	738	558	162	1510	417	220	111		23	12
Mermaid	2485	2647	1954	556	164	1533	354	232	188			
Minta Bella	2906	4178	278	556	163	1519	380	196	152		22	12
Mona	3557	1873	1324	72		1388	373	301	12		22	13
Monterey	2295	3560	273			408	44	44		840		
Muriel	1376	4216		443	127	890	255	110	79		17	194
Nancy B	3536	1661	1328	557	162	1507	489	272				
Naomi	2265	1744	1640			832	61	210	148	30		
Nora	405	711				180	45	45				
Orpha	3519	3975	278	563	164	1576	560	198	13		23	13
Pomona	2870	5425	168	543	158	964	275	21	13	11	602	13
Powella	2479	4394	277			172	44	44				1372
Pretoria	2543	4133	288			410	44	89	46	4	457	155
Primrose	3406	4583	548	539	159	1319	320	121	104	356	21	12
Queenie	916	2908		501	165	956	334	116	12		22	12
Rosel	3189	5135	278	553	163	1070	217	67	13	933	20	12
Rosemary	3399	4223	482	195	162	1241	202	215	197		23	13
Santa Clara	2399	3208	3753	554	161	1587	304	269	225			
Santa Rosa	2674	3747	1764	556	162	1395	442	239	15		18	134
Serena	2882	5619	114	558	161	1083	341	44	13	1065	23	13
Sonoma	3038	4647	354	565	155	1097	368	72	13	779	23	12
Star Bright	2749	5608	277	566	162	1597	371	168	106	10	564	12
Stella	2929	5747	108	267	162	520	199	33	12	1232	21	12
Stephanie	472	2161		557	163	1087	435	84	13		23	12
Surprise	2075	2897	228	514	147	1107	416	133	7		21	7
Sylvia	186		28			52	14	14				
Una	2390	3702	221	561	159	1234	356	158	100		22	12
Ursula	3228	5511	278	502	124	1168	254	75	12	10	942	12
Vivian	2514	4811	278	553	159	1134	257	61	15	902	17	9
Yemassee	369	2041		559	164	1010	415	64	13		22	13
Yuba	2705	3659	1836	63		1332	352	252	13	145	30	13

***Roughly 25 percent of rowen fed was green or partly dried; the remainder was rowen hay.**

WHAT KIND OF CORN SHALL BE PLANTED FOR SILAGE?

The wet summers of 1902 and 1903 and the consequent immature corn crop have served better than any Experiment station test to deter farmers from further planting of varieties which will not mature in normal seasons; yet a brief account of trials made in 1900 and 1901, in the seasons before those in which "the rains descended and the floods came" may not be amiss, nor their moral lost.

Four varieties of corn, Sanford, Red Cob, Leaming and a dent corn from Virginia, much vaunted by an institute speaker in Vermont during the winter of 1899-1900, were planted each year.

Sanford corn is a relatively small flint corn, largely grown and favorably known throughout northern New England. Red Cob is a larger variety, which frequently will nearly and occasionally quite mature at Burlington. Leaming is a larger variety, popular in southern New England, characterized in particular by a highly developed leaf growth. The Virginia corn (variety unknown) was a large, impressive looking dent corn, for which great things were claimed as to its growth in latitudes south of 40°.

The plantings of 1900 were made on three pieces, one of sandy loam, a good garden and corn land, the other heavier and of a clay loam type. Two pieces were used the second year, one of each kind. The plots were of irregular size the first year, varying from one-eighth to three-quarters of an acre in size and aggregating three acres in all. The following year the trial plots were either a third or a sixth of an acre in size. Exact uniformity of soil, as to past manuring, etc., could not be secured, but since the trial plots were long and narrow it is thought that material errors were not introduced. Inasmuch, however, as very general deductions alone are drawn, extreme exactness was not deemed a necessity.

The following table shows the tonnage yields of corn and of dry matter to the acre:

	1900				1901			
	Total crop	Dry matter			Total crop	Dry matter		
	Tons per acre	Percent	Tons per acre	Stage of maturity†	Ton per acre	Percent	Tons per acre	Stage of maturity†
	9.6	81.7	8.0	b	8.9	82.	2.7	a
Sanford	8.1	85.2	2.8	a	12.2	85.8	4.4	a
	8.9	80.4	2.7	b				
	14.6	22.9	8.8	c	14.1	28.9	8.8	c
Red Cob	12.2	26.1	8.2	b	17.1	22.4	8.8	c
	15.7	20.8	8.2	d				
	16.1	18.4	8.0	f	*—			
Leaming	14.6	21.1	8.1	c	—			
	16.1	16.9	2.7	f				
	14.8	20.9	8.1	e	14.7	28.4	.4	q
Virginia	17.4	21.8	8.7	c	15.6	26.5	.1	o
	18.1	19.7	8.6	f				
Averages:								
Sanford	8.9	81.5	2.8	b	10.6	84.	8.6	a
Red Cob	14.2	22.5	8.2	c	15.6	28.	8.6	c
Leaming	15.6	18.6	2.9	e	—			
Virginia	16.8	20.8	8.5	e	15.2	25.	8.8	b

*Leaming seed not true to name.
† a. Mature. Ears glazing.
b. Nearly mature. Ears beginning to glaze.
c. Ears in dough.
d. Ears in milk, small.
e. Few ears and small, just forming.
f. No ears.

The record of the Virginia corn on field II in 1900 is a doubtful one. It seems likely that there was some error of weight or of harvest made, but nothing can be said with certainty on this point.

The larger corns produced from 50 to 70 percent more gross weight than did the Sanford, but only an average of 10 percent more dry matter, and that was less mature.

The several crops were ensiled. It was found impracticable to make exact separations in the silo, so that only general statements are possible. The silages were fed to many cows and the surface dropped rapidly, which tended to lessen loss. According to the records for 1900 the two dryer corns, Sanford and Red Cob, when ensiled, lost but 2 percent in total weight, while the wetter ones, Leaming and Virginia, lost 20 percent. The latter lost 14 percent of dry matter and the for-

mer seemed to gain a small amount of dry matter, an obvious impossibility. The dry matter loss, however, can confidently be stated to have been slight. Assuming 5 percent loss in the one case and 14 percent in the other, less dry matter was actually put into the cows' mangers from an area planted to the large varieties than was derived from an equal area planted to the smaller kinds. The comparison was not made with the crop of 1901.

The silages were fed in the course of the feeding trials of 1900-1901 and of 1901-1902. When cows were changed from Sanford silage to that derived from the larger corn, shrinkage in milk flow ensued if no increase was made in the weight of silage fed in order to offset its lessened feeding value.

The Red Cob and Virginia corns were ensiled separately from the Sanford. The following table shows the average analyses of the corns as they were harvested and as they emerged from the silo as silage. Each analysis shown in the table is the average of the analyses of twelve samples and ought to be fairly represetative of the truth. The Sanford silage samples, however, represent the general growth of the year rather than that of the experimental plot.

			Composition of dry matter							
	Water	Dry matter	Crude ash	Crude protein	Crude fiber	Nitrogen free extract	Ether extract	Nitrogen	Phosphoric acid	Potash
Crop of 1900 as harvested										
Sanford	67.89	32.11	5.14	8.68	16.40	66.82	2.96	1.39	0.51	1.45
Red Cob	76.53	23.47	6.15	8.32	21.32	62.13	2.08	1.34	0.53	1.52
Leaming	80.99	19.01	6.66	8.58	23.70	59.85	1.21	1.37	0.48	1.95
Virginia	79.42	20.58	7.80	8.75	24.51	57.74	1.20	1.40	0.52	1.91
Crops of 1901 as harvested										
Sanford	66.06	33.94	5.37	7.84	17.93	65.89	2.97	1.26	0.50	1.38
Red Cob	76.83	23.17	5.33	7.60	20.23	64.47	2.37	1.22	0.49	1.42
Virginia	75.05	24.95	6.25	7.67	25.12	59.53	1.43	1.24	0.52	1.66
As taken from silo as silage										
Sanford	68.49	31.51	5.76	9.14	19.11	62.77	3.22	1.46	0.60	1.66
Red Cob and Virginia	78.06	21.94	6.64	8.75	28.34	54.38	1.89	1.40	0.55	1.82

It will be noted that:

1. The dry matter of the Sanford corn tends to be a shade richer in protein, a good deal richer in the more desirable carbo-

hydrates (starches, etc., fat) and less rich in its less desirable form (cellulose) than the other varieties. This no doubt is largely due to its greater maturity; that

2. Its dry matter carries less potash than that of its rivals, a good point in its favor; that

3. The dry matter of its silage is better in the same direction that the dry matter of the green corn proved superior.

The large corns look impressive, but they yield at best but little and often no more actual food matter than do some smaller varieties. One has the satisfaction of seeing immense growths, but gets no other return. The farmer has, moreover, to harvest and house large tonnages of water which may generally be procured cheaper in other ways.

HOW LONG MAY A FINISHED BABCOCK TEST BE PRESERVED UNIMPAIRED?

Four Babcock tests of milk, made by the writer in late September, 1900, at the Valley Fair grounds, Brattleboro, were used to determine the possibility of preserving them for great lengths of time. The bottles containing the acid liquid and supernatant fat were placed in a dark cupboard in the dairy building, where they remained for three years, through winter's cold and summer's heat, experiencing temperatures below zero and approximating 100° F. These bottles and their contents were inspected annually in late September, warmed to 120-130° F,. whirled in a Babcock centrifugal for a minute or two, the fats reread, and their conditions noted. The tests were made on fresh, unpreserved milks, in a hand tester. The results are appended:

Year	Percent fat	Condition as regards clarity of fat	Conditions as regards curd
1900	5.15	Clear	One minute speck
1901	5.25	"	A little curd
1902	5.20	"	Some black curd below fat
1903	5.20	Somewhat cloudy	Much curd
1900	4.60	Clear	Very slight specks
1901	4.60	"	"
1902	4.50	"	Some curd
1903	4.70	Rather cloudy	Much curd
1900	4.80	Clear	Some curd
1901	4.80	"	"
1902	4.80	"	"
1903	lost		
1900	4.60	Clear	Slight specks
1901	4.60	"	Some curd
1902	4.40	"	Much more curd than others
1903	3.80 (?)	Very cloudy	Large amount of curd; pratically impossible to read

A year's keeping in the dark in heat and cold did not impair the reading. Two years did not materially affect the results save that there was considerable "curd" formed which partly obscured the readings. By the end of the third year their values were largely gone. During this year, however, the bottles had been moved to another building, and seemed to have absorbed some water.

These results are of interest as indicating the possibilities of preserving the actual analyzed material for future use in cases of dispute. It seems likely that a capped and sealed test-bottle, kept in the dark, in a cool place ought to present readable contents for a year, or, indeed, two years after the tests were made, unless perchance the preservative, if such were used, should have some ill-effect.

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APPENDIX CONTAINING CONDENSED DATA PERTAINING TO ARTICLE ON FEEDING TRIALS WITH COWS

I. Weights of cows.

II. Average barn temperatures, with ranges and percentages of uniformity.

III. Analyses and digestible ingredients in fodders and feeds: (*a*) analyses on dry basis; (*b*) digestion co-efficients; (*c*) pounds of digestible nutrients in 100 pounds of original substance.

IV. Feeding records of the individual cows in feeding tests.

V. Production records; showing production and same per unit for each individual cow in feeding tests.

VI. Difference tables: (*a*) total differences; (*b*) percentage differences.

VII. Results of experimental feeding on different rations.

I. WEIGHTS OF COWS

Period	Pomona	Lucerne	Max Belle	Atalanta	Maid Marian	Elsa	Flora	Eunice	Fresno	Inez
I begin	....	803	913	955	888	878	873	....	....	....
I end	799	795	925	935	885	902	885	....	....	....
II	793	832	928	932	898	905	882	810	856	830
III	805	800	900	907	905	862	868	834	867	820
IV	803	822	933	888	863	917	883	800	877	838
V	838	818	937	860	892	943	920	810	900	860

Period	Lady Perusia	Linnet	Serena	Stella	Sonoma	Monterey	Janice	Vivian	Juanita	Katrina
I begin	....	....	....	823	....	....	....	....	....	610
I end	....	....	855	802	....	890	804	....	....	623
II	980	507	837	807	868	903	837	880	782	622
III	965	523	845	829	872	927	822	872	777	634
IV	972	532	835	843	870	929	860	892	830	628
V	948	518	810	848	840	....	897	912	855	....

Period	Beautina	Bertha	Primrose	Rosemary	Goldenrod	Rosel		Lavender	Pretoria	Star Bright
I begin	....	868	....	....	....	....	....	913	....	990
I end	948	917	....	830	1007	....	....	910	....	992
II	977	938	935	838	1021	1024	....	947	885	1000
III	993	955	955	843	1016	1003	....	973	890	1004
IV	1038	977	940	840	1012	1035	....	1007	893	988
V	....	....	918	823	1019	1043	....	....	893	1010

Period	Ursula	Dorothy	Edith	Lorna Doone	Santa Clara	Minta Bella	Mermaid	Eva	Ceres	Santa Rosa
I begin	980	....	....	730	789	773	848	869	....	813
I end	947	....	....	772	782	785	828	920	....	778
II	960	....	793	798	887	815	887	948	897	792
III	970	892	785	815	869	817	887	943	887	828
IV	997	895	786	862	903	....	930	....	870	852
V	1013	907	822	....	937	....	....	....	878	913

Period	Yuba	Naomi	Acme	Nancy B	Hallowe'en	Mona	Powella		Una	Dahlia
I begin	918	....	955	1003	813	953	788	....	638	958
I end	927	807	983	1022	848	993	793	....	660	952
II	948	817	1007	1032	850	1042	828	....	706	965
III	942	850	998	1075	838	1028	825	....	720	1015
IV	973	818	1032	1125	853	1042	817	....	....	....
V	1000	....	....	....	....	....	818	....	....	....

II. AVERAGE BARN TEMPERATURES, WITH RANGES AND PERCENTAGES OF UNIFORMITY

Period No.		Average temperature			Range of temperature			Percent of whole within 8° F. of mean		
		5 AM	12 M	6 PM	5 AM	12 M	6 PM	5 AM	12 M	6 PM
MAIN BARN										
I	Pre	47	42	45	36-52	32-48	36-51	56	50	50
	Exp	55	50	52	48-62	42-56	44-57	52	74	65
II	Pre	49	47	49	40-57	42-54	43-55	67	67	67
	Exp	53	49	52	42-64	36-56	40-58	43	52	57
III	Pre	52	49	51	43-60	40-57	48-57	58	67	83
	Exp	57	52	55	50-64	45-63	50-60	70	74	78
IV	Pre	60	58	58	54-66	50-68	50-66	67	75	42
	Exp	58	55	56	48-64	48-61	46-60	65	78	70
V	Pre	58	61	62	51-64	50-78	52-78	33	42	42
	Exp	62	69	72	52-71	59-81	58-83	52	22	13

Period No.		Average temperature			Range of temperature			Percent of whole within 8° F. of mean		
		5 AM	12 M	6 PM	5 AM	12 M	6 PM	5 AM	12 M	6 PM
ANNEX BARN										
I	Pre	44	41	45	28-52	34-45	40-50	73	60	80
	Exp	53	52	53	48-64	44-60	48-58	57	70	74
II	Pre	50	52	52	30-60	44-56	46-56	42	75	50
	Exp	54	52	55	46-60	45-59	47-60	48	65	65
III	Pre	52	52	53	47-62	46-57	48-57	67	83	75
	Exp	56	56	57	43-63	48-64	51-63	65	57	70
IV	Pre	60	63	61	48-68	58-72	56-71	58	83	50
	Exp	57	59	60	50-63	52-69	53-64	57	48	70
V	Pre	58	67	66	46-68	56-80	52-80	58	25	42
	Exp	61	74	73	48-69	58-85	58-85	57	30	35

III. ANALYSES AND DIGESTIBLE INGREDIENTS IN FODDERS AND FEEDS

(*a*) ANALYSES ON DRY BASIS; (*b*) DIGESTION COEFFICIENTS; (*c*) POUNDS OF DIGESTIBLE NUTRIENTS IN ONE HUNDRED POUNDS OF ORIGINAL SUBSTANCE

(*a*) ANALYSES ON DRY BASIS

Fodders and feeds	Dates of sampling	Original substance		Composition of dry matter							
		Water	Dry matter	Crude ash	Crude protein	Crude fiber	Nitrogen-free extract	Ether extract	Nitrogen	Phosphoric acid	Potash
Hay, main barn	Period I	12.52	87.48	8.70	9.41	36.70	43.52	1.67	1.51	0.56	2.58
	" II	14.76	85.24	7.75	8.51	33.53	48.21	2.00	1.36	0.55	2.07
	" III	14.71	85.29	7.90	10.19	32.38	47.50	2.03	1.63	0.55	2.15
	" IV	13.35	86.65	8.42	11.50	31.69	46.46	1.93	1.84	0.62	2.34
	" V	11.79	88.21	8.85	10.60	32.72	45.74	2.09	1.70	0.83	2.28
Hay, annex barn	Period I	11.45	88.55	8.10	9.47	36.34	44.54	1.55	1.52	0.47	2.58
	" II	13.59	86.41	7.00	8.41	37.20	45.63	1.76	1.35	0.45	1.97
	" III	14.16	85.84	8.21	9.86	36.35	43.84	1.74	1.58	0.52	2.52
	" IV	13.32	86.68	8.24	9.40	36.25	44.28	1.83	1.50	0.54	2.77
	" V	9.31	90.69	9.03	11.59	34.88	42.58	1.92	1.85	0.69	2.56
Corn silage	Period I	79.56	20.44	7.97	9.28	25.49	54.66	2.60	1.49	0.76	2.25
	" II	76.98	23.02	7.16	8.93	26.37	55.25	2.29	1.43	0.69	2.05
	" III	78.11	21.89	7.75	9.62	27.69	52.56	2.38	1.54	0.68	2.19
	" IV	78.86	21.14	7.53	9.56	25.56	55.22	2.13	1.53	0.69	2.09
	" V	76.09	23.91	7.98	9.38	23.20	56.84	2.60	1.50	0.62	1.97
Apple pomace silage	Period I, II	75.80	24.20	4.69	6.61	17.37	66.64	4.69	1.06	0.44	1.06
	" III, IV	75.20	24.80	4.56	7.41	18.87	63.68	5.48	1.19	0.47	0.94
	" V	75.90	24.10	5.12	7.65	18.45	63.37	5.41	1.22	0.46	0.93
Pumpkins	Period I	87.90	12.10	9.28	10.86	13.76	61.59	4.51	1.74	1.20	3.7
Mixed feed No. 1	Dec. to Feb.	11.70	88.30	7.80	28.25	10.20	48.16	5.59	4.52	3.16	1.88
	Feb. to May	11.00	89.00	7.99	25.53	10.75	49.13	6.60	4.09	3.06	1.87
Mixed feed No. 2	Dec. to Feb.	10.00	90.00	6.10	26.38	13.17	48.60	5.75	4.22	1.93	1.01
	Feb. to May	12.80	87.20	6.18	24.05	14.48	49.41	5.88	3.85	1.92	0.67
Mixed feed No. 3	Feb.	10.35	89.65	4.22	31.78	13.33	40.11	10.56	5.08	1.33	0.84
	Feb. to May	8.90	91.10	4.36	29.11	13.76	43.51	9.26	4.65	1.41	0.75
Mixed feed No. 6	Jan.	10.98	89.02	4.27	19.94	14.52	53.16	8.11	3.19	1.53	0.95
Mixed feed No. 7	Dec. to Feb.	12.90	87.10	7.09	23.31	8.81	55.48	5.31	3.73	2.75	1.95
	Feb. to May	12.20	87.80	7'81	23.61	9.31	53.74	5.53	3.78	2.78	1.78
Wheat bran	Dec. to Feb.	12.55	87.45	7.89	18.13	10.69	58.24	5.05	2.90	3.13	1.94
	Feb. to May	11.75	88.25	8.15	17.63	10.96	58.19	5.07	2.82	3.12	1.94
Cottonseed meal	Dec. to Feb.	8.32	91.68	8.61	49.58	5.25	27.17	9.39	7.93	3.52	2.24
	Feb. to May	7.35	92.65	8.61	48.54	5.42	26.07	11.36	7.77	3.56	2.16
Linseed meal	Dec. to Feb.	10.51	89.49	6.31	42.37	8.78	38.74	3.80	6.78	2.12	1.40
	Feb. to May	11.10	88.90	5.68	38.94	8.74	38.94	7.70	6.23	1.84	1.31
Dried brewers grains	Dec. to Feb.	7.12	92.88	4.65	32.03	13.95	43.37	6.00	5.13	1.08	0.34
	Feb. to May	14.30	85.70	5.04	25.06	16.27	47.58	6.05	4.01	1.08	0.09
Dried distillers grains	Dec. *	8.62	91.38	2.47	37.94	11.57	32.77	15.25	6.07	0.74	0.40
	Jan. †	9.92	90.08	2.80	20.52	15.26	52.37	9.05	3.28	0.75	0.45
	Feb. to March ‡	8.75	91.25	2.57	38.30	13.32	33.38	12.43	6.13	0.71	0.28
	Feb. to May	7.40	92.60	2.47	35.66	13.73	37.44	10.70	5.71	0.54	0.14
Nutrene No. 5	Dec. to Feb.	12.50	87.50	15.25	18.96	20.23	42.29	3.27	3.03	1.62	1.32
	Feb. to May	12.60	87.40	15.36	19.28	21.99	39.75	3.62	3.08	1.72	1.30
Corn meal	Dec. to Feb.	15.30	84.70	2.25	11.68	2.27	81.91	1.89	1.87	0.83	0.40
	Feb. to May	17.60	82.40	2.11	10.87	1.99	83.20	1.83	1.74	0.76	0.39

*** Merchants' Dairy Feed. † xx rye grains. ‡ xxxx alcohol grains.**

(b) DIGESTION COEFFICIENTS*

	Dry matter	Crude protein	Crude fiber	Nitrogen-free extract	Ether extract
Hay†	60	57	58	64	57
Silage‡	73	68	75	77	82
Apple pomace	72	..	61	84	41
Mixed feed No. 1§	67	83	39	71	78
" " " 2§	62	79	47	62	84
" " " 3§	74	74	80	78	87
" " " 7§	69	81	31	75	77
Wheat bran	62	78	29	69	68
Cottonseed meal	74	88	56	61	93
Linseed meal	79	85	80	86	97
Dried brewers' grains	62	79	53	58	91
Dried distillers' grains (No. 4)	80	73	100	85	91
Nutrene (No. 5)	..	..	..	..	..
Corn meal	89	68	..	95	92

* From tables of digestibility of American feeding stuffs; Jordan and Hall, Bul. 77 Office Exp. Sta. (1900).

† Assumed to be two-thirds timothy in bloom and one-third red clover.

‡ Mature flint (Sanford) corn, (Jordan and Hall, pp. 77, 83).

§ Calculated from analyses of their ingredients and from digestion coefficients of the same.

(c) POUNDS OF DIGESTIBLE NUTRIENTS IN ONE HUNDRED POUNDS OF ORIGINAL SUBSTANCE

Fodders and feeds	Digestible nutrients					Nutritive ratio, 1:
	Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	
Hay, main barn	52.5	4.7	18.6	24.4	0.8	9.5
	51.1	4.1	16.6	26.3	1.0	11.0
	51.2	5.0	16.0	25.9	1.0	8.8
	52.0	5.7	15.9	25.7	1.0	7.7
	52.9	5.3	16.7	25.8	1.0	8.5
Hay, annex barn	53.1	4.8	18.7	25.2	0.8	9.5
	51.8	4.1	18.6	25.2	0.9	11.2
	51.5	4.8	18.1	24.1	0.8	9.2
	52.0	4.6	18.2	24.6	0.9	9.7
	54.4	6.0	18.3	24.7	1.0	7.6
Silage, mature corn	14.9	1.2	3.9	8.6	0.4	11.2
	16.8	1.3	4.6	9.8	0.4	11.8
	16.0	1.3	4.5	8.9	0.4	11.0
	15.4	1.3	4.1	9.0	0.4	10.8
	17.5	1.4	4.2	10.5	0.5	11.3
Silage, apple pomace	17.4	...	2.6	13.5	0.5	...
	17.9	...	2.8	13.3	0.6	...
	17.4	...	2.7	12.8	0.5	...
Mixed feed No. 1	59.2	20.7	3.5	30.2	3.9	2.1
	59.6	18.9	3.7	31.0	4.6	2.4
Mixed feed No. 2	55.8	18.8	5.6	27.1	4.4	2.3
	54.1	16.6	5.9	26.7	4.3	2.5
Mixed feed No. 3	65.9	13.0	10.3	36.9	6.3	4.7
	66.3	21.1	9.5	28.0	8.2	2.7
	67.4	19.6	10.0	30.9	7.3	2.9
Mixed feed No. 7	60.1	16.4	2.4	36.2	3.6	2.8
	60.6	16.8	2.5	35.4	3.7	2.8
Wheat bran	54.2	12.4	2.7	35.1	3.0	3.6
	54.7	12.1	2.8	35.4	3.0	3.7
Cottonseed meal	67.9	40.0	2.7	15.2	8.0	0.9
	68.6	39.6	2.8	14.7	9.8	1.0
Linseed meal	70.7	32.2	6.3	29.8	3.3	1.4
	70.2	29.4	6.2	29.8	6.6	1.7
Dried brewers' grains	57.6	23.5	6.9	23.4	5.1	1.8
	53.1	17.0	7.4	23.6	4.7	2.4
Dried distillers' grains (No. 4) Dec	73.1	25.3	10.6	25.4	12.7	2.6
Jan	72.1	13.5	13.4	40.1	7.4	5.2
Feb.-Mar.	73.0	25.5	12.1	25.9	10.3	2.4
	74.1	24.1	12.7	29.4	9.0	2.6
Nutrene (No. 5)						
Corn meal	75.4	6.7		65.9	1.5	10.3
	73.3	6.1		65.1	1.4	11.2

IV. FEEDING RECORDS OF INDIVIDUAL COWS

Name of cow	Low, medium and high feeding / Period numbers	Nature of ration, (No. 2)	Pounds eaten of: Hay	Silage	Wheat bran	Dried brewers' grains	Dried distillers' grains	Pounds eaten of total dry matter in entire ration	Pounds eaten of total dry matter in experimental feed	Pounds of digestible nutrients eaten during period: Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	Nutritive ratio, 1:
POMONA	I. Pre.	No. 2 Medium	...	...	...	....		.....	.....	.....	....	....	.....	....	...
	Exp.	"	240	552	61	122		491.6	164.9	312.3	53.4	76.6	157.8	12.2	4.9
	II. Pre.	V'ry low	131	288	8	16		205.3	21.6	129.8	13.7	38.9	67.7	3.5	8.4
	Exp.	"	258	552	15	31		385.7	41.4	252.1	26.7	76.0	131.6	6.5	8.3
	III. Pre.	Medium	131	284	30	60		256.3	80.6	163.4	27.4	41.5	81.4	6.1	5.0
	Exp.	"	263	549	60	110	11	500.3	155.9	322.9	49.3	83.5	162.0	12.3	5.5
	IV. Pre.	V'ry low	135	288	8	16		199.9	20.8	127.5	13.7	37.8	65.6	3.4	8.1
	Exp.	"	249	552	15	31		370.8	40.1	239.3	26.1	70.6	123.5	6.3	8.0
	V. Pre.	Medium	126	287	30	60		256.8	78.8	167.2	26.0	40.5	85.6	6.5	5.4
	Exp.	"	233	549	61	122		513.2	162.9	321.5	51.0	76.5	164.8	12.7	5.3
LUCERNE	I. Pre.	V'ry low	142	298	8	16		204.5	21.7	133.3	15.0	39.5	67.9	3.4	7.7
	Exp.	"	263	688	15	31		416.9	41.4	268.0	29.8	78.6	138.0	6.9	7.8
	II. Pre.	Medium	127	351	29	57		272.7	77.6	173.0	26.4	44.6	89.8	6.3	5.6
	Exp.	"	246	672	61	121		524.6	163.6	342.4	53.9	86.8	177.4	12.9	5.4
	III. Pre.	V'ry low	133	349	8	16		213.0	21.5	137.8	15.5	41.3	69.7	3.5	7.7
	Exp.	"	262	677	15	28	3	411.2	39.6	268.5	28.9	80.8	136.1	6.9	8.0
	IV. Pre.	Medium	127	322	29	59		255.9	76.1	163.0	24.8	41.5	84.0	6.1	5.6
	Exp.	"	244	628	57	113		489.9	148.1	315.1	46.6	80.1	162.6	11.8	5.8
	V. Pre.	V'ry low	132	344	7	13		213.9	17.5	142.8	15.9	39.8	74.1	3.8	7.7
	Exp.	"	249	673	14	29		434.0	38.3	276.5	31.2	76.4	143.9	7.7	7.6
MAX BELLE	I. Pre.	Medium	141	265	32	64		262.6	86.9	167.4	28.3	41.9	83.8	6.4	4.9
	Exp.	"	255	548	61	122		501.5	164.9	318.3	53.9	79.0	159.1	12.3	4.9
	II. Pre.	"	137	283	32	63		272.5	85.7	170.8	27.6	41.0	89.5	6.7	5.3
	Exp.	"	254	552	61	123		502.5	165.4	325.7	53.1	77.9	170.9	12.8	5.2
	III. Pre.	"	141	288	32	63		266.9	85.0	171.6	29.0	40.9	87.9	6.8	5.0
	Exp.	"	267	550	60	111	11	506.6	156.8	325.0	50.4	78.8	168.2	13.0	5.5
	IV. Pre.	"	136	286	32	64		264.7	83.0	166.4	26.9	39.0	86.7	6.5	5.2
	Exp.	"	257	552	61	123		495.2	160.3	317.8	51.2	74.4	165.7	12.5	5.2
	V. Pre.	"	135	288	29	59		260.9	77.0	169.2	25.3	39.8	88.8	6.5	5.7
	Exp.	"	215	545	59	119		484.5	158.4	305.0	47.5	69.3	160.9	12.4	5.4
ATALANTA	I. Pre.	V'ry low	140	301	8	24		203.4	21.7	131.8	14.8	39.0	66.6	3.4	7.6
	Exp.	"	268	690	15	31		419.0	41.4	269.3	29.8	79.4	137.1	6.9	7.8
	II. Pre.	"	135	357	8	24		224.2	21.6	142.5	14.7	40.1	77.0	3.9	8.6
	Exp.	"	236	685	15	31		393.3	41.4	261.5	27.5	73.8	141.7	7.1	8.4
	III, Pre.	"	137	359	8	24		215.4	21.5	141.0	16.2	39.4	74.0	3.9	7.5
	Exp.	"	259	688	15	28	3	413.0	39.6	268.0	29.4	75.3	141.0	7.5	7.9
	IV. Pre.	"	138	358	8	24		220.2	20.8	139.8	16.4	38.0	74.2	3.8	7.4
	Exp.	"	266	690	15	30		410.1	39.2	268.9	31.9	73.3	142.6	7.4	7.3
	V. Pre.	"	138	358	8	24		223.6	21.0	148.6	16.1	39.4	179.7	4.2	8.0
	Exp.	"	213	689	15	31		400.9	40.9	258.1	28.3	67.2	139.8	7.4	7.9

Name of cow	Low, medium and high feeding / Period numbers	Nature of ration, (No. 2)	Pounds eaten of: Hay	Silage	Wheat bran	Dried brewers' grains	Dried distillers' grains		Pounds eaten of total dry matter in entire ration	Pounds eaten of total dry matter in experimental feed	Pounds of digestible nutrients eaten during period: Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	Nutritive ratio, 1:
MAID MARIAN	I. Pre.	Low	136	267	7	15			191.6	19.9	123.5	13.8	36.9	62.1	3.2	7.7
	Exp.	“	269	552	30	61			431.6	82.0	274.5	36.8	76.7	137.9	8.3	6.3
	II. Pre.	V'ry low	138	288	8	16			210.5	21.6	132.4	14.0	37.4	71.0	3.7	8.4
	Exp.	“	259	550	15	31			382.2	41.4	250.6	26.7	70.9	134.5	6.8	8.3
	III. Pre.	Low	134	288	14	28			213.6	37.6	138.3	18.5	36.8	71.7	4.3	6.4
	Exp.	“	262	546	31	56	5		423.8	79.2	272.2	35.2	72.2	141.8	8.8	6.6
	IV. Pre.	V'ry low	139	288	8	15			204.6	19.9	129.1	15.4	35.3	67.9	3.6	7.2
	Exp.	“	262	552	15	31			379.3	40.1	246.0	29.5	67.0	129.5	6.7	7.2
	V. Pre.	Low	135	287	15	31			224.0	40.3	146.4	18.6	37.4	77.3	4.8	6.7
	Exp.	“	239	552	30	61			430.1	81.0	272.1	35.0	68.5	144.4	9.0	6.7
ELSA	I. Pre.	V'ry low	184	316	8	16			245.2	21.7	157.2	17.0	47.8	78.6	3.9	8.0
	Exp.	“	358	690	15	31			497.4	41.4	316.6	34.0	96.1	159.1	7.6	8.0
	II. Pre.	Low	178	358	16	32			283.8	43.4	178.1	21.2	48.6	94.9	5.4	7.3
	Exp.	“	319	677	30	61			501.4	81.8	327.8	39.5	89.2	175.0	9.9	7.3
	III. Pre.	V'ry low	176	328	8	16			241.8	21.5	156.1	17.7	44.3	81.3	4.2	7.6
	Exp.	“	357	664	15	28	3		491.6	39.6	314.3	34.0	89.9	164.3	8.4	8.0
	IV. Pre.	Low	187	327	15	30			274.0	38.9	171.9	22.2	45.8	89.7	5.1	6.6
	Exp.	“	347	674	29	59			514.3	76.6	331.6	42.7	88.0	173.6	9.9	6.6
	V. Pre.	V'ry low	188	354	7	15			264.6	19.3	173.4	18.5	47.6	91.7	4.6	8.1
	Exp.	“	302	686	15	31			479.2	40.9	304.7	33.0	81.9	162.4	8.3	8.0
FLORA	I. Pre.	Low	140	268	16	32			218.8	43.4	140.4	19.0	39.1	70.2	4.4	6.3
	Exp.	“	253	551	31	61			418.5	82.9	266.5	36.3	73.8	134.1	8.2	6.2
	II. Pre.	“	133	288	16	32			227.9	43.4	143.4	18.4	37.9	76.2	4.7	6.8
	Exp.	“	253	551	31	61			418.7	82.7	273.5	35.4	72.5	145.5	8.7	6.7
	III. Pre.	“	130	287	16	32			215.4	43.0	139.5	19.4	36.3	72.2	4.6	6.1
	Exp.	“	254	552	31	56	5		418.3	79.2	269.0	34.9	71.1	140.2	8.7	6.6
	IV. Pre.	“	133	288	16	32			221.0	41.5	139.4	19.0	35.8	73.1	4.5	6.3
	Exp.	“	257	551	31	61			414.8	80.1	268.1	36.6	69.0	140.5	8.6	6.3
	V. Pre.	“	134	288	16	32			225.0	42.0	147.1	18.6	37.3	77.9	4.7	6.8
	Exp.	“	232	552	31	61			424.8	81.9	268.9	34.8	67.4	142.7	8.9	6.6

Name of cow	Low, medium and high feeding / Period numbers	Nature of ration, (No. 8)	Pounds eaten of: Hay	Silage	Wheat bran	Dried distillers' grains	Pounds eaten of total dry matter in entire ration	Pounds eaten of total dry matter in experimental feed	Pounds of digestible nutrients eaten during period: Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	Nutritive ratio, 1:
EUNICE	III. Pre.	No. 8 Medium	135	358	25	50	258.5	66.5	176.8	27.3	44.7	88.3	8.9	5.6
	Exp.	"	265	689	59	118	538.7	160.0	365.4	57.3	90.6	184.9	18.2	5.5
	IV. Pre.	V'ry low	140	359	8	15	222.1	20.7	143.7	17.3	39.3	75.4	4.4	7.2
	Exp.	"	265	690	15	31	411.9	41.9	275.2	83.2	74.9	144.4	8.8	7.2
	V. Pre.	Medium	136	356	29	58	279.6	79.1	192.9	29.4	46.1	99.6	9.5	5.7
	Exp.	"	236	678	49	97	511.7	134.0	342.1	50.9	82.1	177.5	16.3	5.8
FRESNO	III. Pre.	V'ry low	139	360	8	15	217.1	21.3	144.8	16.8	40.6	74.8	4.7	7.5
	Exp.	"	266	690	15	31	421.4	41.6	277.7	31.4	78.2	144.6	8.8	7.7
	IV. Pre.	"	132	360	8	16	216.2	21.6	140.2	17.1	38.1	73.9	4.4	7.1
	Exp.	"	250	690	15	31	399.0	41.9	267.4	32.3	72.6	140.6	8.6	7.2
	V. Pre.	"	135	360	8	16	222.3	21.8	150.6	17.0	39.9	80.1	4.9	7.7
	Exp.	"	216	690	15	31	405.1	42.2	266.2	30.2	69.6	142.5	9.0	7.7
INEZ	III. Pre.	No. 8 V'ry low	142	359	8	16	219.5	21.3	146.1	16.9	41.1	75.6	4.7	7.5
	Exp.	"	270	688	15	31	424.4	41.6	279.4	31.5	78.7	145.4	8.8	7.7
	IV. Pre.	"	141	360	8	16	224.0	21.6	144.9	17.6	39.5	76.2	4.5	7.1
	Exp.	"	274	690	15	31	419.7	41.9	279.9	33.7	76.4	146.7	8.8	7.2
	V. Pre.	"	142	360	8	16	228.4	21.8	154.3	17.3	41.1	81.9	4.9	7.7
	Exp.	"	251	688	15	31	435.7	42.2	284.3	32.0	75.3	151.3	9.2	7.7
Lady Perusia	III. Pre.	Low	141	360	16	32	240.1	42.6	161.8	21.9	43.3	82.2	6.7	6.4
	Exp.	"	271	683	31	61	465.7	83.2	310.2	40.7	83.0	159.6	12.0	6.6
	IV. Pre.	V'ry low	136	360	8	16	219.7	21.6	142.3	17.3	38.7	74.9	4.5	7.2
	Exp.	"	263	688	15	31	409.8	41.9	273.9	33.0	74.5	143.8	8.7	7.2
	V. Pre.	Low	138	360	16	32	246.7	43.6	168.4	21.8	42.7	88.4	6.6	6.7
	Exp.	"	246	688	31	61	473.5	84.5	312.6	40.8	78.9	164.3	12.5	6.6
LINNET	III. Pre.	V'ry low	106	170	7	15	146.2	19.5	96.2	12.1	26.6	48.9	3.6	6.9
	Exp.	"	223	368	15	31	313.7	41.6	204.2	25.1	56.8	104.9	7.0	7.1
	IV. Pre.	Low	108	179	14	28	171.5	37.9	112.2	16.8	28.6	57.0	4.8	5.7
	Exp.	"	213	367	29	59	339.2	80.1	226.7	34.3	57.4	115.2	9.9	5.7
	V. Pre.	V'ry low	115	288	9	18	191.0	24.5	129.4	15.4	33.9	68.3	4.5	7.3
	Exp.	"	199	358	14	28	304.1	38.6	196.4	23.8	51.8	102.0	6.8	7.1

Name of cow	Nos. 3, 4 and 2 Period numbers	Nature of ration	Pounds eaten of: Hay	Silage	Wheat bran	Dried distillers' grains	Dried brewers' grains		Pounds eaten of total dry matter in entire ration	Pounds eaten of total dry matter in experimental feed	Pounds of digestible nutrients eaten during period: Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	Nutritive ratio, 1:
SEREÑA	II. Pre.	No. 4	134	286	2	93			270.7	85.8	185.2	31.8	46.3	90.1	11.8	5.1
	Exp.	"	251	552		178			495.4	160.9	350.4	61.1	87.7	169.2	22.7	5.0
	III. Pre.	No. 3	140	287	30	65			265.2	84.3	176.9	29.5	43.6	87.2	9.7	5.2
	Exp.	"	270	550	61	121			516.9	164.5	349.1	56.7	85.7	175.5	18.0	5.3
	IV. Pre.	No. 4	139	284	2	84			262.6	78.8	179.4	32.2	44.5	86.8	10.1	4.8
	Exp.	"	254	552		169			488.8	156.5	342.3	62.3	84.5	164.7	19.9	4.7
	V. Pre.	No. 3	137	286	28	63			268.2	82.9	184.6	29.6	44.0	93.4	9.6	5.4
	Exp.	"	284	552	53	105			489.7	145.0	327.1	51.4	77.6	167.5	16.5	5.5
STELLA	I. Pre.	No. 4	138	291		93			264.5	84.7	184.3	32.9	48.0	85.5	11.7	4.9
	Exp.	"	259	653		144			496.9	132.2	339.5	55.5	90.6	161.2	19.2	5.3
	II. Pre.	"	134	334		90			278.8	81.5	190.9	31.9	50.8	91.2	11.6	5.3
	Exp.	"	254	643		173			517.8	156.4	365.4	61.2	96.9	174.7	22.3	5.3
	III. Pre.	"	133	332		87			266.2	78.4	184.8	32.0	49.3	85.6	11.0	5.0
	Exp.	"	259	675		158			514.4	145.7	358.5	59.3	97.4	168.9	19.0	5.2
	IV. Pre.	"	126	355		85			264.3	78.0	183.2	30.9	48.3	88.0	10.2	5.2
	Exp.	"	252	659		158			501.5	146.3	349.7	58.3	93.0	167.7	19.1	5.2
	V. Pre.	"	121	340		77			257.2	71.4	182.4	30.7	46.2	88.2	9.8	5.1
	Exp.	"	230	633		167			524.4	155.6	359.6	62.9	89.9	172.4	20.5	4.9
SONOMA	III. Pre.	No. 3	131	281	2	92			256.6	84.6	180.1	33.2	44.4	84.9	11.8	4.7
	Exp.	"	263	537		164			494.7	151.2	342.1	59.7	87.1	164.1	19.5	4.9
	IV. Pre.	No. 4	138	281	29	64			266.2	83.9	178.2	30.2	42.5	89.7	9.3	5.1
	Exp.	"	263	550	61	121			505.3	165.6	344.4	58.2	82.1	173.7	17.9	5.1
	V. Pre.	No. 3	137	284	2	67			248.7	63.9	172.9	27.7	43.5	85.5	8.9	5.4
	Exp.	"	214	542		116			432.5	108.1	294.1	46.9	73.2	146.2	15.3	5.4
MONTEREY	II. Pre.	No. 4	142	286	2	47			236.1	44.2	155.9	20.8	42.4	79.5	7.2	6.6
	Exp.	"	254	552		153			475.4	138.3	333.7	55.1	85.3	163.1	20.1	5.3
	III. Pre.	No. 3	137	288	30	65			262.8	84.3	179.9	30.9	43.9	88.1	10.4	5.0
	Exp.	"	266	548	61	122			514.0	165.4	347.5	56.6	85.1	174.6	18.1	5.3
	IV. Pre.	No. 4	134	283	28	62			261.7	82.5	179.6	32.8	44.2	86.6	10.4	4.7
	Exp.	"	259	552		157			482.0	145.4	336.0	59.7	83.7	162.5	18.8	4.8
JANICE	II. Pre.	No. 2	129	288	29	4	52		257.6	76.6	162.6	25.0	39.6	85.9	6.4	5.6
	Exp.	"	231	513	56		111		459.1	150.1	297.9	48.4	71.3	156.5	11.7	5.3
	III. Pre.	No. 3	134	258	28	52	4		244.1	74.6	165.2	27.8	40.6	81.5	8.9	5.1
	Exp.	"	263	529	47	92			467.5	125.7	313.1	47.6	79.4	158.4	14.7	5.7
	IV. Pre.	No. 2	127	280	28	4	52		244.5	72.0	154.7	24.4	36.8	80.7	6.0	5.4
	Exp.	"	238	544	53		107		456.3	139.4	293.8	46.2	69.5	153.6	11.3	5.4
	V. Pre.	No. 3	127	283	28	51	4		251.1	75.3	172.8	27.1	41.2	88.2	8.6	5.5
	Exp.	"	208	525	42	84			430.6	115.7	287.0	43.3	69.0	148.0	13.8	5.7

Name of cow	Nos. 2 and 3 / Period numbers	Nature of ration	Pounds eaten of: Hay	Silage	Wheat bran	Dried brewers' grains	Dried distillers' grains	Pounds eaten of total dry matter in entire ration	Pounds eaten of total dry matter in experimental feed	Pounds of digestible nutrients eaten during period: Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	Nutritive ratio, 1:
VIVIAN	III. Pre.	No. 3	124	270	32		63	247.9	84.3	170.0	29.7	40.8	83.2	10.0	4.9
	Exp.	"	250	495	62		122	489.5	166.3	331.4	55.3	80.1	166.1	17.7	5.2
	IV. Pre.	"	120	277	32		62	250.6	84.8	168.6	29.1	39.6	85.0	9.1	5.0
	Exp.	"	228	463	57		112	445.5	153.8	304.0	52.4	71.7	153.0	16.4	5.0
	V. Pre.	"	131	254	27		55	247.1	74.5	169.2	26.7	40.6	82.0	8.5	5.3
	Exp.	"	172	514	60		119	444.5	164.3	301.8	51.7	67.7	154.1	17.2	5.0
JUANITA	III. Pre.	No. 2	124	286	32	60	4	253.0	85.9	163.8	28.6	38.3	83.8	6.8	4.8
	Exp.	"	259	547	60	111	8	496.2	153.9	318.2	49.1	77.0	164.9	12.6	5.5
	IV. Pre.	No. 3	132	284	31	4	57	260.5	82.8	173.6	29.3	41.2	87.9	8.9	5.1
	Exp.	"	244	550	58		118	483.5	160.2	330.4	55.9	78.5	167.0	17.3	5.1
	V. Pre.	No. 2	138	282	19	35	4	236.2	51.0	154.5	20.7	38.6	81.2	5.4	6.4
	Exp.	"	233	549	57	114		495.3	152.2	311.6	47.4	72.1	164.0	12.2	5.6
KATRINA	I. Pre.	No. 2	111	217	21	43		197.8	57.9	126.5	20.2	32.8	63.2	4.6	5.3
	Exp.	"	201	455	40	80		378.2	108.1	240.6	38.1	61.7	120.7	8.7	5.3
	II. Pre.	"	109	240	19	37		202.7	50.5	127.4	18.4	32.2	67.4	4.6	6.0
	Exp.	"	190	457	38	77		365.4	103.4	238.4	35.9	58.9	126.1	8.8	5.7
	III. Pre.	"	109	232	20	41		197.2	54.6	127.1	20.3	31.2	65.4	4.7	5.3
	Exp.	"	210	456	39	76	2	380.7	100.4	243.9	35.1	61.1	126.8	8.9	5.9
	IV. Pre.	"	107	221	17	33		185.4	43.3	116.6	17.0	29.1	61.1	4.1	5.8
	Exp.	"	208	453	37	73		368.5	95.8	237.6	35.3	58.3	124.3	8.5	5.7
BEAUTINA	II. Pre.	No. 2	138	288	32	60	4	275.4	86.5	173.4	27.6	41.7	91.3	7.0	5.4
	Exp.	"	249	550	61	123		497.9	165.4	322.9	52.9	76.9	169.4	12.8	5.2
	III. Pre.	No. 3	140	288	32	4	60	266.3	85.2	181.2	30.9	44.1	89.2	10.2	5.1
	Exp.	"	269	550	61		123	517.8	166.3	349.9	57.1	85.6	175.9	18.1	5.3
	IV. Pre.	No. 2	132	288	32	60	4	261.9	83.3	165.6	26.9	38.8	86.2	6.7	5.2
	Exp.	"	254	540	61	123		490.2	160.3	314.5	50.8	73.4	163.8	12.4	5.2
BERTHA	I. Pre.	No. 2	137	265	32	64		259.0	86.9	165.3	28.1	41.2	82.3	6.4	4.9
	Exp.	"	264	552	61	121		509.3	164.0	322.9	54.1	80.8	161.4	12.3	5.0
	II. Pre.	"	138	288	32	63		274.6	85.7	172.2	27.7	41.4	90.3	6.8	5.3
	Exp.	"	254	552	60	121		499.8	162.7	324.0	52.5	77.7	170.1	12.7	5.3
	III. Pre.	"	131	286	30	59		252.8	79.7	162.8	27.5	38.9	83.6	6.3	5.0
	Exp.	"	267	537	56	112		490.9	144.0	313.2	47.3	76.9	162.5	11.9	5.6
	IV. Pre.	"	136	288	32	63		264.3	82.2	166.3	26.7	39.0	86.6	6.6	5.3
	Exp.	"	256	550	59	117		486.9	153.3	312.7	49.9	73.7	163.0	12.2	5.3

Name of cow	Nos. 1 and 3 / Period numbers	Nature of ration, (No. 2)	Pounds eaten of: Hay	Silage	Wheat bran	½ cottonseed meal ½ linseed meal	Dried brewers' grains	Nutrene	Pounds eaten of total dry matter in entire ration	Pounds eaten of total dry matter in experimental feed	Pounds of digestible nutrients eaten during period: Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	Nutritive ratio, 1:
PRIMROSE	III. Pre.	No. 1	139	288	62	30	4		267.7	84.1	175.0	30.2	41.9	88.3	6.3	4.8
	Exp.	"	266	552	122	61			509.1	161.6	334.4	55.1	79.5	169.9	12.6	5.0
	IV. Pre.	No. 3	134	288	34	2	60		263.8	85.6	177.8	28.7	45.0	88.5	9.1	5.4
	Exp.	"	243	552	59		120		488.4	162.9	332.1	53.8	84.2	165.2	18.0	5.4
	V. Pre.	No. 1	129	286	62	30	4		266.1	85.6	178.0	30.2	39.5	91.7	7.2	4.9
	Exp.	"	232	552	122	62			516.0	165.4	332.5	56.9	72.3	172.3	13.6	4.8
ROSEMARY	II. Pre.	No. 1	130	264	60	30		24	261.9	84.8	169.3	27.1	40.1	89.2	5.9	5.3
	Exp.	"	256	552	122	62			504.9	162.3	334.2	55.4	79.3	174.7	11.7	5.1
	III. Pre.	"	137	288	60	30			265.8	84.0	173.5	30.0	41.1	87.9	6.0	4.8
	Exp.	"	268	552	122	62			511.7	162.5	336.0	55.4	79.9	170.7	12.9	5.0
	IV. Pre.	"	136	288	60	30			265.3	85.4	172.3	28.4	40.1	89.2	6.8	5.1
	Exp.	"	252	552	122	62			497.0	163.6	325.8	54.1	75.1	168.7	13.0	5.0
	V. Pre.	"	135	288	60	30			271.6	85.4	181.0	30.5	40.3	93.3	7.2	4.9
	Exp.	"	253	552	122	62			535.3	165.4	343.9	58.2	76.1	177.5	13.8	4.9
GOLDENROD	II. Pre.	No. 1	180	360	62	30	4		327.0	84.4	209.8	31.3	50.2	112.3	7.1	5.7
	Exp.	"	334	690	121	61			596.6	161.4	394.9	60.2	93.3	211.2	13.2	5.6
	III. Pre.	No. 3	179	351	34	2	60		312.9	85.1	211.4	33.8	53.0	105.1	10.7	5.4
	Exp.	"	350	671	61		123		613.0	165.4	410.8	62.6	104.0	207.6	19.4	5.7
	IV. Pre.	No. 1	179	353	59	29	4		315.9	81.9	202.9	32.6	46.8	106.4	7.6	5.2
	Exp.	"	344	687	122	61			600.4	162.7	393.8	63.7	89.5	206.9	14.5	5.3
	V. Pre.	No. 3	181	346	32	2	55		318.1	80.7	215.9	32.1	53.0	110.7	9.8	5.8
	Exp.	"	293	678	61		122		596.3	168.0	397.2	61.2	95.2	205.7	19.5	5.6
ROSEL	III. Pre.	No. 1	161	288	32		64		287.9	85.2	192.9	31.7	51.1	91.8	10.2	5.2
	Exp.	"	345	552	61		123		580.1	165.4	390.2	60.2	105.3	189.3	18.0	5.6
	IV. Pre.	"	177	287	32		64		301.3	86.6	201.3	30.8	53.3	99.2	9.6	5.7
	Exp.	"	320	552	61		123		560.3	167.4	377.5	58.3	98.6	185.6	18.3	5.6
	V. Pre.	"	165	288	32		64		300.2	87.3	205.0	32.9	51.6	100.9	10.0	5.3
	Exp.	"	299	552	61		123		581.2	168.9	383.5	62.0	95.7	189.1	19.0	5.3
LAVENDER	I. Pre.	No. 3	187	263	64	32		10	258.9	85.4	168.7	29.5	38.9	86.5	6.0	4.7
	Exp.	"	253	552	122	62			501.3	163.0	325.4	56.4	75.1	167.4	11.4	4.8
	II. Pre.	"	136	288	64	32			272.5	84.4	175.6	29.0	41.9	91.7	6.1	5.1
	Exp.	"	261	552	122	62			509.1	162.3	336.8	55.6	80.3	175.9	11.7	5.1
	III. Pre.	"	187	288	64	32			265.8	84.0	173.5	30.0	41.1	87.9	6.0	4.8
	Exp.	"	264	552	122	62			508.3	162.5	334.0	55.2	79.2	169.7	12.8	5.0
PRETORIA	III. Pre.	No. 3	184	287	26		32		*240.5	64.7	155.4	23.6	39.4	78.5	6.9	5.7
	Exp.	"	263	550	60		120		509.1	162.7	344.3	56.0	84.5	178.1	17.8	5.8
	IV. Pre.	"	126	282	30		59		252.4	80.3	169.0	28.5	40.2	85.6	8.8	5.1
	Exp.	"	250	542	50		101		464.3	137.4	315.4	51.1	76.6	160.1	15.6	5.3
	V. Pre.	"	132	279	26		52		250.2	70.9	171.3	26.2	41.3	87.7	8.3	5.6
	Exp.	"	228	539	46		93		463.8	127.6	308.7	47.1	74.2	158.6	15.0	5.7

*Pretoria had 10 lbs. Nutrene, for which there are no digestion coefficients.

Name of cow	Nos. 1 and 2 / Period numbers	Nature of ration	Pounds eaten of: Hay	Silage	Wheat bran	½ cottonseed meal ½ linseed meal	Dried brewers' grains		Pounds eaten of total dry matter of entire ration	Pounds eaten of total dry matter in experimental feed	Pounds of digestible nutrients eaten during period: Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	Nutritive ratio, 1:
STAR BRIGHT	I. Pre.	No. 2	138	267	32		64		260.3	86.9	166.2	28.2	41.4	82.7	6.4	4.9
	Exp.	"	265	551	62		122		511.8	165.8	324.4	54.6	81.1	162.0	12.4	5.0
	II. Pre.	No. 1	140	288	62	30	4		275.2	84.5	176.6	29.0	39.8	94.0	6.4	5.1
	Exp.	"	267	552	122	61			509.3	161.4	337.4	55.6	74.9	180.1	12.0	5.1
	III. Pre.	No. 2	140	288	34	2	60		267.0	85.9	171.9	29.3	40.6	88.2	6.8	4.9
	Exp.	"	267	550	62		111	10	507.5	157.6	325.5	50.5	78.9	168.5	13.0	5.5
	IV. Pre.	No. 1	138	288	63	30	4		270.0	86.2	174.5	30.3	37.6	91.4	7.2	4.8
	Exp.	"	269	552	122	62			508.9	163.6	334.6	57.8	72.0	175.4	13.4	4.8
	V. Pre.	No. 2	138	274	34	2	60		267.4	84.1	173.1	26.7	40.0	90.7	6.9	5.5
	Exp.	"	223	535	59		117		487.3	156.6	306.5	47.5	70.1	161.4	12.3	5.5
URSULA	I. Pre.	No. 2	186	255	32		64		302.9	86.9	190.7	30.5	50.1	94.9	6.7	5.2
	Exp.	"	321	552	62		122		564.0	165.8	355.9	57.5	91.8	178.4	12.9	5.2
	II. Pre.	"	167	286	32		64		301.5	86.6	184.4	29.0	49.9	96.0	6.8	5.6
	Exp.	"	337	552	62		122		577.1	165.4	370.5	56.5	98.8	188.7	13.3	5.6
	III. Pre.	"	168	288	32		64		294.7	85.9	186.5	30.3	48.9	92.2	6.7	5.2
	Exp.	"	342	552	61		112	10	570.6	158.5	365.8	53.7	97.8	181.8	13.1	5.8
	IV. Pre.	"	179	288	32		64		299.6	83.0	189.5	27.3	50.1	95.9	6.8	5.9
	Exp.	"	334	550	62		122		565.1	160.3	358.1	52.0	94.3	181.6	12.9	5.9
	V. Pre.	"	175	288	32		64		305.8	84.0	197.3	29.9	49.8	99.4	7.2	5.5
	Exp.	"	326	551	62		122		600.6	163.8	372.9	56.7	93.7	188.3	13.8	5.5
DOROTHY	III. Pre.	No. 1														
	Exp.	"	258	526	109	55			481.6	144.8	314.0	51.2	70.9	164.4	12.2	5.1
	IV. Pre.	No. 2	136	278	31	2	54		255.4	75.5	160.8	25.6	38.0	83.9	6.2	5.3
	Exp.	"	246	540	55		111		467.6	144.6	300.6	47.6	71.0	156.9	11.7	5.3
	V. Pre.	No. 1	131	287	60	29	4		262.9	82.7	175.5	28.8	37.7	92.8	7.1	5.1
	Exp.	"	187	545	113	57			454.0	152.8	295.6	50.1	60.2	158.1	12.4	4.9
EDITH	III. Pre.	No. 1	114	285	64	32			242.4	84.0	160.8	29.1	34.3	84.2	5.9	4.5
	Exp.	"	227	542	121	62			475.3	161.6	312.0	53.5	67.3	163.7	12.9	4.9
	IV. Pre.	"	117	288	64	32			251.0	85.4	162.4	28.8	33.9	85.9	6.8	4.7
	Exp.	"	220	552	122	62			466.5	163.6	309.1	55.0	64.2	163.3	12.9	4.7
	V. Pre.	"	116	282	64	32			251.5	85.4	168.0	28.4	34.7	89.3	7.0	4.9
	Exp.	"	238	552	122	62			513.6	165.4	332.2	55.6	69.5	176.4	13.7	5.0
LORNA DOONE	I. Pre.	No. 1	115	212	47	24			205.7	63.2	134.0	22.5	32.0	67.9	4.5	4.9
	Exp.	"	213	457	89	44			398.8	117.8	258.6	42.8	61.9	131.9	8.7	5.0
	II. Pre.	No. 2	109	240	24	2	41		212.5	60.3	133.8	20.6	32.8	70.6	5.0	5.6
	Exp.	"	191	408	43		87		368.8	116.9	239.0	38.2	57.8	125.6	9.2	5.3
	III. Pre.	No. 1	110	218	46	23	3		203.6	63.1	133.7	23.0	30.0	69.7	4.8	4.8
	Exp.	"	216	447	92	46			405.3	121.9	264.3	43.1	59.7	138.5	10.3	5.1
	IV. Pre.	No. 2	113	236	48	24			214.7	64.1	138.0	23.4	30.3	72.6	5.3	4.9
	Exp.	"	218	456	91	45			402.5	120.9	264.7	44.3	58.3	139.3	10.3	5.0

Name of cow	Corn and pomace silages — Period numbers	Nature of ration	Pounds eaten of: Hay	Silage	Wheat bran	½ cottonseed meal ½ linseed meal	Apple pomace silage	Pounds eaten of total dry matter in entire ration	Pounds eaten of total dry matter in experimental feed	Pounds of digestible nutrients eaten during period: Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	Nutritive ratio, 1:
SANTA CLARA	I. Pre.	Pomace	131		64	32	323	269.8	68.5	181.8	25.9	36.0	104.8	6.3	6.0
	Exp.	"	222		121	60	793	560.0	206.2	361.8	47.5	68.0	216.4	12.9	6.6
	II. Pre.	Silage	123	390	64	32	29	291.1	99.2	190.4	29.8	42.4	103.7	6.7	5.4
	Exp.	"	213	812	117	59		516.4	182.7	349.4	55.4	78.8	189.3	12.2	5.3
	III. Pre.	Pomace	126	25	62	31	394	286.9	98.8	194.1	25.7	35.5	115.5	7.4	6.5
	Exp.	"	244		122	61	802	582.4	211.7	377.4	47.3	68.1	226.5	15.6	7.0
	IV. Pre.	Silage	122	388	62	32	24	281.8	92.1	183.4	30.0	39.3	98.5	7.2	5.1
	Exp.	"	229	785	121	61		520.0	160.1	348.5	58.1	75.1	186.0	13.7	5.0
	V. Pre.	Pomace	114	26	61	30	387	283.9	103.5	186.4	23.9	33.8	109.8	7.3	6.7
	Exp.	"	167	32	102	52	723	478.7	172.0	311.5	38.9	54.2	186.7	12.6	6.9
MINTA B'LA	I. Pre.	Silage	136	268	64	32		257.2	51.5	168.1	29.3	39.1	85.4	5.9	4.7
	Exp.	"	261	552	122	61		504.8	115.4	327.5	56.4	76.3	166.4	11.3	4.8
	II. Pre.	"	137	288	64	32		272.4	68.3	175.2	29.0	39.2	93.5	6.3	5.1
	Exp.	"	254	552	122	62		499.4	124.2	331.4	55.3	73.9	177.0	11.9	5.0
	III. Pre.	"	139	287	64	32		264.0	62.3	173.9	30.4	38.4	90.8	6.2	4.7
	Exp.	"	268	552	122	62		513.6	121.4	335.2	55.9	74.3	175.5	13.4	5.0
MERMAID	I. Pre.	Silage	143	266	64	32		264.9	51.1	172.3	29.7	40.4	88.2	5.9	4.8
	Exp.	"	267	552	122	62		513.6	115.4	322.9	57.1	77.7	170.9	11.5	4.8
	II. Pre.	Pomace	140	18	64	32	270	275.7	68.0	180.6	25.6	37.8	102.5	6.7	6.1
	Exp.	"	271		122	62	552	523.2	129.7	348.1	48.8	72.3	197.7	12.9	6.1
	III. Pre.	Silage	139	270	64	32	18	268.0	62.9	174.6	29.9	41.2	88.5	6.0	4.8
	Exp.	"	270	552	122	62		513.4	121.4	337.1	55.5	80.3	171.1	12.9	5.1
	IV. Pre.	Pomace	138	4	64	32	284	275.6	72.5	179.0	24.7	36.5	100.5	7.0	6.2
	Exp.	"	256		122	62	552	525.9	138.0	338.9	47.1	68.4	194.0	13.6	6.2
EVA	I. Pre.	Pomace	140		64	31	319	276.1	67.6	185.2	26.1	37.5	106.3	6.4	6.1
	Exp.	"	254		122	62	793	590.4	206.2	380.3	49.6	74.2	225.1	13.2	6.6
	II. Pre.	"	139		64	32	420	305.0	99.1	203.0	25.4	38.2	121.8	7.6	7.0
	Exp.	"	257		122	62	805	567.1	189.4	384.3	48.2	71.5	230.8	14.6	7.0
	III. Pre.	"	132		63	32	419	294.2	99.3	198.8	26.1	36.0	118.9	7.5	6.6
	Exp.	"	261		122	62	803	598.2	212.0	387.0	48.4	70.9	231.4	15.9	7.0
CERES	II. Pre.	Silage													
	Exp.	"	261	552	122	62		503.0	124.2	336.7	47.9	73.1	189.9	11.4	6.0
	III. Pre.	Pomace	141	151	39	19	197	249.1	79.5	166.6	18.5	36.3	97.3	5.3	7.9
	Exp.	"	272		122	62	659	567.5	174.0	368.4	43.6	66.4	224.4	13.7	7.4
	IV. Pre.	Silage	130	314	57	29	16	261.9	73.7	170.8	25.5	36.1	94.8	6.0	5.7
	Exp.	"	271	690	122	62		536.8	140.8	358.3	54.4	75.8	198.1	12.5	5.6
	V. Pre.	Pomace	140	21	64	32	339	296.4	90.2	194.8	23.3	35.8	116.1	6.8	7.2
	Exp.	"	255	30	122	62	690	554.0	164.0	371.4	43.5	66.9	223.7	13.1	7.4

Name of cow	Corn and pomace silages, pumpkins — Period numbers	Nature of ration	Pounds eaten of: Hay	Pounds eaten of: Silage	Pounds eaten of: Wheat bran	Pounds eaten of: ½ cottonseed meal ½ linseed meal	Pounds eaten of: Pumpkins	Pounds eaten of: Apple pomace silage	Pounds eaten of total dry matter in entire ration	Pounds eaten of total dry matter in experimental feed	Pounds of digestible nutrients eaten during period: Dry matter	Pounds of digestible nutrients eaten during period: Protein	Pounds of digestible nutrients eaten during period: Crude fiber	Pounds of digestible nutrients eaten during period: Nitrogen-free extract	Pounds of digestible nutrients eaten during period: Ether extract	Nutritive ratio, 1:
SANTA ROSA	II. Pre.	Silage	140	286	38	19	*14		251.1	67.8	153.2	18.5	37.7	85.2	4.5	7.1
	Exp.	"	244	551	122	62			488.6	124.0	327.8	47.2	70.2	185.4	11.2	5.9
	III. Pre.	Pomace	138	132	41	20	*5	150	238.3	64.2	155.4	18.5	33.7	89.7	5.0	7.3
	Exp.	"	271		122	62		552	538.3	145.7	348.7	43.6	63.3	210.0	13.0	6.9
	IV. Pre.	Silage	138	287	64	32			267.5	63.7	174.0	27.2	36.0	96.0	6.1	5.4
	Exp.	"	267	551	122	62			505.0	112.4	334.8	52.4	69.5	184.7	11.9	5.4
	V. Pre.	Pomace	139	17	64	32		270	277.2	71.9	181.5	23.2	33.5	107.0	6.5	6.7
	Exp.	"	246	36	120	61		514	504.9	125.6	335.1	43.0	60.8	198.4	12.2	6.7
YUBA	II Pre.	Silage	135	284	37	19			234.0	67.3	150.4	18.3	36.8	83.7	4.5	7.1
	Exp.	"	256	552	122	62			498.8	124.2	334.1	47.7	72.3	188.6	11.4	6.0
	III. Pre.	Pomace	140	120	57	25	*12	168	266.1	65.8	178.7	24.8	36.1	102.1	7.5	6.2
	Exp.	"	272		122	62		548	538.2	144.7	348.5	43.6	63.2	209.7	13.0	6.9
	IV. Pre.	Silage	140	288	64	32			269.5	63.9	175.2	27.3	36.4	96.6	6.2	5.4
	Eyp.	"	269	552	122	62			506.9	112.6	336.0	52.5	69.8	185.3	11.9	5.4
	V. Pre.	Pomace	141		63	32		288	278.8	72.6	182.1	23.0	33.6	107.6	6.4	6.8
	Exp.	"	238	36	122	62		494	495.9	121.0	329.3	43.1	58.9	194.8	12.1	6.5
NAOMI	II. Pre.	Pomace	136	15	60	30	*6	268	270.3	66.9	177.6	25.7	34.6	101.9	7.2	5.9
	Exp.	"	254		122	62		501	492.9	117.7	328.3	48.1	62.5	189.6	12.7	5.8
	III. Pre.	Silage	135	242	62	32		18	253.4	56.8	166.4	29.2	36.2	87.5	6.2	4.7
	Exp.	"	258	488	120	60			487.4	107.4	317.5	53.8	69.8	166.0	12.4	4.9
	IV. Pre.	Pomace	139	4	62	31		213	258.2	54.6	165.4	25.9	31.4	92.3	6.8	5.4
	Exp.	"	256		113	57		367	464.2	91.7	298.3	47.1	56.7	165.5	12.2	5.8
ACME	I. Pre.	Pomace	262		64	32		48	323.9		203.4	29.0	49.8	106.7	6.4	5.9
	Exp.	"	408		122	62		230	592.5		365.0	50.9	82.6	199.1	12.1	6.1
	II. Pre.	P'mpk's	143	10	64	32	505		274.3	63.0						
	Exp.	"	295	172	122	62	825		552.5	135.7						
	III. Pre.	Pomace	217		64	32		120	301.5		190.1	24.5	41.7	108.1	6.4	6.7
	Exp.	"	419		122	62		230	565.3		365.9	47.2	80.4	208.0	12.2	6.7
	IV. Pre.	"	232		64	32		120	307.9		198.0	27.2	42.8	111.1	6.5	6.2
	Exp.	"	453		122	62		230	609.3	60.7	384.2	52.7	83.3	214.3	12.9	6.2
	V. Pre.	"	234		64	32		120	317.4	30.2	200.6	29.0	42.7	110.3	6.5	5.8
	Exp.	"	435		122	62		230	595.4	57.5	377.3	54.9	79.8	207.5	12.6	5.8
NANCY B.	I. Pre.	Pomace	239		64	32		48	303.9		191.4	27.9	45.8	100.9	6.2	5.8
	Exp.	"	404		122	62		230	569.0		362.9	50.7	81.9	198.2	12.0	6.1
	II. Pre.	P'mpk's	139	10	64	32	505		270.7	63.0						
	Exp.	"	283	195	122	62	825		547.0	140.6						
	III. Pre.	Pomace	215		64	32		120	299.7		189.1	24.4	41.4	107.5	6.4	6.6
	Exp.	"	412		122	62		230	559.5		362.3	46.9	79.2	206.2	12.1	6.7
	IV. Pre.	"	227		64	32		120	303.7		195.4	27.0	42.0	109.8	6.5	6.2
	Exp.	"	447		122	62		230	604.2	60.7	381.2	52.4	82.3	212.8	12.9	6.2
	V. Pre.	"	234		64	32		120	317.4	30.2	200.6	29.0	42.7	110.3	6.5	5.8
	Exp.	"	439		122	62		230	598.8	57.5	379.4	55.2	80.5	208.5	12.6	5.7

* Nutrene.

Name of cow	Pomace, pumpkins, Nos. 1, 3 and 5 — Period numbers	Nature of ration	Pounds eaten of — Hay	Silage	Wheat bran	½ cottonseed meal ½ linseed meal	Apple pomace	Pumpkins	Pounds eaten of total dry matter in entire ration	Pounds eaten of total dry matter in experimental feed	Pounds of digestible nutrients eaten during period — Dry matter	Protein	Crude fiber	Nitrogen-free extract	Ether extract	Nutritive ratio, 1:
HALLOWE'EN	I. Pre.	Pomace	254		64	32	48		316.9		201.5	28.6	48.4	104.7	6.3	5.8
	Exp.	"	393		120	61	230		556.8		355.3	49.7	79.9	194.2	11.8	6.1
	II. Pre.	P'mpk's	139	10	64	32		505	272.5	63.0						
	Exp.	"	278	195	121	62		825	544.5	140.6						
	III. Pre.	Pomace	229		64	32	120		313.5		197.8	25.0	48.5	108.4	6.3	6.8
	Exp.	"	436		122	62	230		586.1		377.6	47.9	92.8	206.9	11.9	6.8
	IV. Pre.	"	225		63	32	120		306.6		194.5	26.3	46.5	105.0	5.8	6.3
	Exp.	"	445		121	61	225		596.4	59.4	379.4	54.1	91.8	202.5	11.7	5.9
	V. Pre.	"	222		64	32	107		300.3	27.0	192.6	25.8	45.6	103.0	6.1	6.3
	Exp.	"	417		119	60	230		580.0	57.5	365.9	48.4	85.5	196.6	11.8	6.4
MONA	I. Pre.	Pomace	241		64	32	48		305.6		192.2	28.0	46.1	101.4	6.2	5.8
	Exp.	"	415		122	62	230		578.6		368.6	51.3	83.8	200.9	12.2	6.1
	II. Pre.	P'mpk's	142	10	64	32		451	266.9	56.5						
	Exp.	"	295	156	122	62		821	548.7	131.9						
	III. Pre.	Pomace	222		64	32	120		305.8		192.6	24.7	42.6	109.4	6.4	6.7
	Exp.	"	430		122	62	230		574.5		371.5	47.6	82.2	210.9	12.3	6.7
	IV. Pre.	"	235		64	32	117		309.7		198.9	27.4	43.2	111.5	6.6	6.2
	Exp.	"	453		122	62	229		609.1	60.5	384.0	52.7	83.3	214.2	12.9	6.2
	V. Pre.	"	231		63	32	120		314.8	30.2	199.0	28.8	42.2	109.5	6.5	5.8
	Exp.	"	446		122	62	230		604.9	57.8	383.0	55.6	81.6	210.3	12.7	5.8
POWELLA						A										
	I. Pre.	No. 5	140	268		93			258.5	81.3						
	Exp.	"	251	552		183			498.5	162.0						
	II. Pre.	"	129	287		95			264.4	82.8						
	Exp.	"	247	552		184			493.1	158.2						
	III. Pre.	"	124	286		95			254.6	84.5						
	Exp.	"	255	552		184			498.6	160.4						
	IV. Pre.	"	126	288		96			258.6	82.2						
	Exp.	"	241	551		181			479.3	155.8						
	V. Pre.	"	131	286		92			261.9	79.6						
	Exp.	"	236	545		169			503.7	151.1						
UNA	I. Pre.	No. 1	115	216	48	24			207.4	64.1	135.2	22.8	32.2	68.6	4.6	4.9
	Exp.	"	207	456	89	45			394.3	118.7	255.9	42.7	60.8	130.5	8.7	4.9
	II. Pre.*	"	115	240	30	15			201.4	44.0	125.7	17.0	31.6	67.4	4.0	6.4
	Exp.	"	208	458	90	45			396.5	119.1	263.1	42.2	60.2	140.8	9.2	5.3
	III. Pre.	"	116	239	48	24			213.2	63.0	140.2	23.7	31.8	73.3	5.0	4.9
	Exp.	"	222	460	92	47			413.4	121.9	269.5	43.6	61.2	141.2	10.3	5.2
DAHLIA	I. Pre.	No. 1	128	261	60	31			244.4	81.0	160.0	27.8	37.1	81.4	5.5	4.7
	Exp.	"	248	539	109	54	B		473.1	144.4	307.0	51.6	72.6	156.6	10.5	4.9
	II. Pre.	No. 3	132	286	32	2	58		265.1	81.9	175.9	21.6	43.9	96.9	7.8	7.3
	Exp.	"	219	547	61		122		469.8	163.2	324.8	40.1	79.9	180.2	15.6	7.4
	III. Pre.	No. 1	125	274	57	27	4		242.5	77.1	160.3	28.0	35.7	83.5	6.1	4.7
	Exp.	"	247	532	115	58			481.5	152.8	314.7	52.5	69.6	164.9	12.6	5.0

*** 5 lbs. nutrene fed also; digestion coefficients unknown. A. Nutrene fed to Powella. B. Rye distillers' grains fed to Dahlia.**

V. RECORD SHOWING PRODUCTION AND SAME PER UNIT FOR EACH INDIVIDUAL COW IN FEEDING TESTS.

Name of cow	Low, medium and high feeding / Period numbers	Experimental ration	Dry matter eaten*	Dry matter eaten†	Milk	Total solids	Fat	Total solids	Fat	Weight of products obtained per 100 lbs. of dry mattter eaten					
										In entire ration			In experimental feed		
										Milk	Total solids	Fat	Milk	Total solids	Fat
		No. 2	lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
POMONA	I. Pre.	Medium	....	....	....	....	...	....	....	....	....	...	....	....	...
	Exp.	"	491.6	164.9	389.1	15.34	5.55	59.70	21.61	79.1	12.1	4.40	236.0	36.2	13.1
	II. Pre.	V'ry low	205.3	21.6	198.0	14.88	5.26	29.45	10.41	96.4	14.3	5.07	916.6	136.3	48.2
	Exp.	"	385.7	41.4	366.3	14.41	4.89	52.79	17.91	95.0	13.7	4.64	884.8	127.5	43.3
	III. Pre.	Medium	256.3	80.6	192.1	14.52	5.26	27.88	10.10	75.0	10.9	3.94	238.3	34.6	12.5
	Exp.	"	500.3	155.9	393.5	14.62	5.15	57.51	20.26	78.7	11.5	4.05	252.4	36.9	13.0
	IV. Pre.	V'ry low	199.9	20.8	190.4	14.31	5.02	27.24	9.55	95.2	13.6	4.78	915.5	131.0	45.9
	Exp.	"	370.8	40.1	301.6	14.38	5.06	43.36	15.26	81.3	11.7	4.12	752.1	108.1	38.1
	V. Pre.	Medium	256.8	78.8	183.8	14.32	5.01	26.32	9.20	71.6	10.3	3.58	233.3	33.4	11.7
	Exp.	"	513.2	162.9	389.9	14.37	5.04	56.03	19.63	76.0	10.9	3.83	239.3	34.4	12.0
LUCERNE	I. Pre.	V'ry low	204.5	21.7	195.6	14.67	5.17	28.69	10.12	95.6	14.0	4.95	901.4	132.2	46.6
	Exp.	"	416.9	41.4	371.9	14.60	5.14	54.30	19.11	89.2	13.0	4.58	898.4	131.2	46.2
	II. Pre.	Medium	272.7	77.6	206.9	15.09	5.40	31.21	11.17	75.9	11.4	4.10	266.6	40.2	14.4
	Exp.	"	524.6	163.6	397.2	15.43	5.64	61.28	22.39	75.7	11.7	4.27	242.8	37.5	13.7
	III. Pre.	V'ry low	213.0	21.5	177.0	15.07	5.55	26.68	9.83	83.1	12.5	4.62	823.3	124.1	45.7
	Exp.	"	411.2	39.6	306.0	15.23	5.64	46.60	17.27	74.4	11.3	4.20	772.8	117.7	43.6
	IV. Pre.	Medium	255.9	76.1	175.1	15.36	5.77	26.89	10.11	68.4	10.5	3.95	230.1	35.3	13.3
	Exp.	"	489.9	148.1	365.6	15.65	5.83	57.23	21.32	74.6	11.7	4.35	246.9	38.6	14.4
	V. Pre.	V'ry low	213.9	17.5	182.7	15.19	5.47	27.76	10.00	85.4	13.0	4.68	104.4	15.9	5.7
	Exp.	"	434.0	38.3	347.0	14.98	5.51	51.98	19.12	80.0	12.0	4.41	906.0	135.7	49.9
MAX BELLE	I. Pre.	Medium	262.6	86.9	237.7	14.94	5.14	35.50	12.22	90.5	13.5	4.65	273.5	40.9	14.1
	Exp.	"	501.5	164.9	432.7	15.17	5.40	65.66	23.37	86.3	13.1	4.66	262.4	39.8	14.2
	II. Pre.	"	272.5	85.7	224.0	15.36	5.45	34.41	12.21	82.2	12.6	4.48	261.4	40.2	14.3
	Exp.	"	502.5	165.4	412.4	15.61	5.60	64.38	23.09	82.1	12.8	4.60	249.3	38.9	14.0
	III. Pre.	"	266.9	85.0	209.0	15.59	5.80	32.57	12.12	78.3	12.2	4.54	245.9	38.3	14.3
	Exp.	"	506.6	156.8	377.5	15.86	5.89	59.89	22.25	74.5	11.8	4.39	240.8	38.2	14.2
	IV. Pre.	"	264.7	83.0	189.8	15.49	5.65	29.39	10.72	71.7	11.1	4.05	228.7	35.4	12.9
	Exp.	"	495.2	160.3	354.4	15.61	5.67	55.32	20.10	71.6	11.2	4.06	221.1	34.5	12.5
	V. Pre.	"	260.9	77.0	181.7	15.64	5.67	28.42	10.31	69.6	10.9	3.95	236.0	36.9	13.4
	Exp.	"	484.5	158.4	342.9	15.19	5.52	52.10	18.92	70.8	10.8	3.91	216.5	32.9	11.9
ATALANTA	I. Pre.	V'ry low	203.4	21.7	242.7	12.38	3.75	30.06	9.10	119.3	14.8	4.47	1118.3	138.5	41.9
	Exp.	"	419.0	41.4	430.6	12.21	3.58	52.57	15.42	102.8	12.5	3.68	1040.0	127.0	37.2
	II. Pre.	"	224.2	21.6	225.1	12.17	3.55	27.38	7.98	100.4	12.2	3.56	1042.0	126.8	36.9
	Exp.	"	393.3	41.4	421.0	12.29	3.57	51.77	15.02	107.0	13.2	3.82	1017.0	125.0	36.3
	III. Pre.	"	215.4	21.5	234.3	12.10	3.50	28.35	8.20	108.8	13.2	3.81	1089.6	131.9	38.1
	Exp.	"	413.0	39.6	453.0	12.28	3.62	55.62	16.39	109.7	13.5	3.97	1144.0	140.5	41.4
	IV. Pre.	"	220.2	20.8	222.4	12.23	3.58	27.21	7.96	101.0	12.4	3.62	1069.2	130.8	38.3
	Exp.	"	410.1	39.2	411.9	12.09	3.49	49.81	14.37	100.4	12.1	3.50	1051.9	127.1	36.7
	V. Pre.	"	223.6	21.0	220.7	12.22	3.50	26.98	7.73	98.7	12.1	3.46	1051.0	128.5	36.8
	Exp.	"	400.9	40.9	355.5	12.18	3.61	43.29	12.84	88.7	10.8	3.20	869.2	105.8	31.4

* In total ration. † In experimental portion of ration.

Name of cow	Low, medium and high feeding — Period numbers	Experimental ration	Dry matter eaten *	Dry matter eaten †	Milk	Total solids	Fat	Total solids	Fat	Weight of products obtained per 100 lbs. of dry matter eaten — In entire ration — Milk	In entire ration — Total solids	In entire ration — Fat	In experimental feed — Milk	In experimental feed — Total solids	In experimental feed — Fat
			lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
MAID MARIAN	I. Pre.	Low	191.6	19.9	165.5	13.93	4.76	23.06	7.87	86.4	12.0	4.11	831.6	115.9	39.5
	Exp.	"	431.6	82.0	354.9	13.71	4.73	48.66	16.79	82.2	11.3	3.89	432.9	59.3	20.5
	II. Pre.	V'ry low	210.5	21.6	184.6	13.97	4.70	25.79	8.68	87.7	12.3	4.12	854.6	119.4	40.2
	Exp.	"	382.2	41.4	349.3	13.87	4.60	48.44	16.05	91.4	12.7	4.20	843.8	117.0	38.8
	III. Pre.	Low	213.6	37.6	199.1	14.04	4.95	27.96	9.86	93.2	13.1	4.62	529.5	74.4	26.2
	Exp.	"	423.8	79.2	411.4	14.11	4.81	58.05	19.78	97.1	13.7	4.67	519.4	73.3	25.0
	IV. Pre.	V'ry low	204.6	19.9	198.8	14.00	4.79	27.83	9.52	97.2	13.6	4.65	999.0	139.9	47.8
	Exp.	"	379.3	40.1	348.9	14.01	4.81	48.90	16.77	92.0	12.9	4.42	870.1	122.0	41.8
	V. Pre.	Low	224.0	40.3	194.5	14.19	4.90	27.60	9.53	86.8	12.3	4.25	482.7	68.5	23.7
	Exp.	"	430.1	81.0	329.4	13.80	4.70	45.47	15.48	76.6	10.6	3.60	406.8	56.1	19.1
ELSA	I. Pre.	V'ry low	245.2	21.7	203.4	14.16	4.87	28.80	9.91	83.0	11.7	4.04	937.3	132.7	45.7
	Exp.	"	497.4	41.4	376.9	14.57	5.19	54.94	19.55	75.8	11.0	3.93	910.4	132.7	47.2
	II. Pre.	Low	283.8	43.4	208.5	15.06	5.44	31.41	11.35	73.5	11.1	4.00	480.4	72.4	26.2
	Exp.	"	501.4	81.8	387.0	14.93	5.31	57.78	20.55	77.2	11.5	4.10	473.1	70.6	25.1
	III. Pre.	V'ry low	241.8	21.5	187.0	14.92	5.40	27.89	10.10	77.3	11.5	4.18	869.8	129.7	47.0
	Exp.	"	491.6	39.6	369.9	14.91	5.27	55.15	19.51	75.2	11.2	3.97	934.0	139.3	49.3
	IV. Pre.	Low	274.0	38.9	194.0	14.74	5.27	28.60	10.23	70.8	10.4	3.73	498.7	73.5	26.3
	Exp.	"	514.3	76.6	381.9	15.07	5.44	57.54	20.78	74.3	11.2	4.04	498.6	75.1	27.1
	V. Pre.	V'ry low	264.6	19.3	194.9	15.12	5.40	29.47	10.52	73.7	11.1	3.98	1010.0	152.7	54.5
	Exp.	"	479.2	40.9	319.4	14.98	5.42	47.85	17.31	66.7	10.0	3.61	781.0	117.0	42.3
FLORA	I. Pre.	Low	218.8	43.4	180.9	14.47	5.05	26.18	9.14	82.7	12.0	4.18	416.8	60.3	21.1
	Exp.	"	418.5	82.9	372.7	14.30	5.02	53.30	18.69	89.1	12.7	4.47	449.5	64.3	22.5
	II. Pre.	"	227.9	43.4	208.0	14.35	5.16	29.84	10.74	91.3	13.1	4.71	479.3	68.8	24.7
	Exp.	"	418.7	82.7	400.9	14.10	4.83	56.52	19.36	95.8	13.5	4.62	484.8	68.4	23.4
	III. Pre.	"	215.4	43.0	216.4	14.07	4.90	30.46	10.60	100.5	14.1	4.92	503.3	70.8	24.7
	Exp.	"	418.3	79.2	423.9	13.87	4.68	58.80	19.84	101.3	14.1	4.74	535.2	74.2	25.1
	IV. Pre.	"	221.0	41.5	212.1	13.66	4.50	28.97	9.55	96.0	13.1	4.32	511.0	69.8	23.0
	Exp.	"	414.8	80.1	375.5	13.75	4.61	51.64	17.30	90.5	12.5	4.17	468.8	64.5	21.6
	V. Pre.	"	225.0	42.0	173.2	14.18	4.80	24.55	8.32	77.0	10.9	3.70	412.4	58.5	19.8
	Exp.	"	424.8	81.9	226.0	13.87	4.53	31.35	10.24	53.2	7.4	2.41	275.9	38.3	12.5
EUNICE	III. Pre.	No. 3 Medium	258.5	66.5	303.4	13.99	4.82	42.44	14.61	117.4	16.4	5.65	456.3	63.8	22.0
	Exp.	"	538.7	160.0	618.0	14.03	4.61	86.68	28.52	114.7	16.1	5.29	386.3	54.2	17.8
	IV. Pre.	V'ry low	222.1	20.7	279.2	13.41	4.16	37.43	11.62	126.3	16.9	5.24	1349.0	180.9	56.1
	Exp.	"	411.9	41.9	464.9	13.65	4.36	63.44	20.27	112.9	15.4	4.92	1110.0	151.4	48.4
	V. Pre.	Medium	279.6	79.1	266.9	13.85	4.41	36.97	11.77	95.4	13.2	4.21	337.4	46.7	14.9
	Exp.	"	511.7	184.0	450.9	13.83	4.55	62.34	20.52	88.1	12.2	4.01	336.5	46.5	15.3
FRESNO	III. Pre.	V'ry low	217.1	21.3	131.0	13.82	4.60	18.10	6.02	60.3	8.3	2.77	615.0	85.0	28.3
	Exp.	"	421.4	41.6	240.9	13.90	4.58	33.48	11.03	57.2	8.0	2.62	579.1	80.5	26.5
	IV. Pre.	"	216.2	21.6	119.7	13.62	4.38	16.31	5.24	55.4	7.5	2.42	554.2	75.5	24.3
	Exp.	"	399.0	41.9	224.2	13.81	4.46	30.97	10.00	56.2	7.8	2.51	535.1	73.9	23.9
	V. Pre.	"	222.3	21.8	122.2	13.90	4.55	16.98	5.56	55.0	7.6	2.50	560.6	77.9	25.5
	Exp.	"	405.1	42.2	202.1	13.88	4.63	28.05	9.35	49.9	6.9	2.31	479.0	66.5	22.2

* In total ration. † In experimental portion of ration.

Name of cow	Low, medium and high feeding; Nos. 4 and 3 — Period numbers	Experimental ration	Dry matter eaten *	Dry matter eaten †	Milk	Total solids	Fat	Total solids	Fat	Weight of products obtained per 100 lbs. of dry matter eaten — In entire ration			Weight of products obtained per 100 lbs. of dry matter eaten — In experimental feed		
										Milk	Total solids	Fat	Milk	Total solids	Fat
		No. 3	lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
INEZ	III. Pre.	V'ry low	219.5	21.3	213.9	14.94	5.55	31.95	11.87	97.4	14.6	5.41	1004.0	150.0	55.8
	Exp.	"	424.4	41.6	403.4	14.82	5.35	59.77	21.57	95.1	14.1	5.08	969.7	143.6	51.9
	IV. Pre.	"	224.0	21.6	211.3	14.62	5.20	30.90	10.99	94.3	13.8	4.91	978.5	143.1	50.9
	Exp.	"	419.7	41.9	383.3	14.88	5.33	57.04	20.45	91.3	13.6	4.87	914.8	136.1	48.8
	V. Pre.	"	228.4	21.8	202.9	15.18	5.60	30.81	11.36	88.8	13.5	4.97	930.8	141.5	52.1
	Exp.	"	435.7	42.2	367.7	14.73	5.34	54.13	19.63	84.4	12.4	4.51	871.5	128.3	46.5
L. PERUSIA	III. Pre.	Low	240.1	42.6	264.7	14.76	5.45	39.06	14.43	110.2	16.3	6.01	621.4	91.7	33.9
	Exp.	"	465.7	83.2	505.8	15.04	5.64	76.07	28.54	108.6	16.3	6.13	608.0	91.4	34.3
	IV. Pre.	V'ry low	219.7	21.6	231.9	14.87	5.40	34.49	12.52	105.6	15.7	5.70	1074.0	159.6	58.0
	Exp.	"	409.8	41.9	418.0	15.00	5.43	62.68	22.68	102.0	15.3	5.54	997.8	149.6	54.1
	V. Pre.	Low	246.7	43.6	235.8	15.12	5.60	35.66	13.21	95.6	14.5	5.36	540.9	81.8	30.3
	Exp.	"	473.5	84.5	400.1	14.97	5.55	59.88	22.26	84.5	12.7	4.71	473.5	70.9	26.3
LINNET	III. Pre.	V'ry low	146.2	19.5	206.2	13.31	4.29	27.45	8.84	141.0	18.8	6.05	1057.5	140.8	45.3
	Exp.	"	313.7	41.6	379.3	13.37	4.30	50.73	16.32	120.9	16.2	5.20	911.8	121.9	39.2
	IV. Pre.	Low	171.5	37.9	190.9	13.43	4.35	25.63	8.31	111.3	14.9	4.85	503.9	67.6	21.9
	Exp.	"	339.2	80.1	352.3	14.06	4.83	49.54	17.01	103.9	14.6	5.02	439.8	61.8	21.2
	V. Pre.	V'ry low	191.0	24.5	172.8	13.98	4.77	24.16	8.25	90.5	12.7	4.32	705.6	98.6	33.7
	Exp.	"	304.1	38.6	274.6	13.84	4.75	38.01	13.05	90.3	12.5	4.29	711.5	98.4	33.8
SERENA	II. Pre.	No. 4	270.7	85.8	264.3	13.96	4.61	36.88	12.19	97.6	13.6	4.50	308.0	43.0	14.2
	Exp.	"	495.4	160.9	511.2	13.75	4.47	70.27	22.87	103.2	14.2	4.62	317.7	43.7	14.2
	III. Pre.	No. 3	265.2	84.3	275.7	13.88	4.67	38.26	12.86	104.0	14.4	4.85	327.0	45.4	15.3
	Exp.	"	516.9	164.5	501.3	13.78	4.50	69.07	22.58	97.0	13.4	4.37	304.2	41.9	13.7
	IV. Pre.	No. 4	262.6	78.8	247.5	13.71	4.40	33.94	10.89	94.2	12.9	4.15	314.1	43.1	13.8
	Exp.	"	488.8	156.5	459.9	14.09	4.73	64.79	21.77	94.1	13.3	4.45	293.9	41.4	13.9
	V. Pre.	No. 3	268.2	82.9	241.3	14.00	4.67	33.79	11.28	90.0	12.6	4.21	291.1	40.8	13.6
	Exp.	"	489.7	145.0	390.3	14.13	4.80	55.17	18.72	79.7	11.3	3.82	269.1	38.1	12.9
STELLA	I. Pre.	No. 4	264.5	84.7	324.9	14.53	5.02	47.19	16.32	122.9	17.8	6.17	383.6	55.7	19.3
	Exp.	"	496.9	132.2	642.0	13.83	4.47	88.76	28.70	129.2	17.9	5.78	485.6	67.1	21.7
	II. Pre.	"	278.8	81.5	271.3	13.64	4.30	36.97	11.66	97.3	13.3	4.18	332.9	45.4	14.3
	Exp.	"	517.8	156.4	511.1	13.60	4.22	69.48	21.56	98.7	13.4	4.16	326.8	44.4	13.8
	III. Pre.	"	266.2	78.4	254.6	13.93	4.67	35.46	11.89	95.6	13.3	4.47	324.7	45.2	15.2
	Exp.	"	514.4	145.7	478.9	13.98	4.66	66.94	22.30	93.1	13.0	4.34	328.7	46.0	15.3
	IV. Pre.	"	264.3	78.0	257.6	13.77	4.40	35.48	11.33	97.5	13.4	4.29	330.3	45.5	14.5
	Exp.	"	501.5	146.3	491.5	13.91	4.53	68.37	22.26	98.0	13.6	4.44	336.0	46.7	15.2
	V. Pre.	"	257.2	71.4	264.1	13.94	4.58	36.82	12.09	102.7	14.3	4.70	369.9	51.6	16.9
	Exp.	"	524.4	155.6	540.2	13.76	4.42	74.30	23.87	103.1	14.2	4.55	347.4	47.8	15.3

*** In total ration. † In experimental portion of ration.**

Name of cow	Nos. 3, 4 and 2 / Period numbers	Experimental ration	Dry matter eaten*	Dry matter eaten †	Milk	Total solids	Fat	Total solids	Fat	Weight of products obtained per 100 lbs. of dry matter eaten: In entire ration: Milk	In entire ration: Total solids	In entire ration: Fat	In experimental feed: Milk	In experimental feed: Total solids	In experimental feed: Fat
			lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
SONOMA	III. Pre.	No. 3	256.6	84.6	298.1	14.74	5.33	43.21	15.61	114.2	16.8	6.08	346.5	51.1	18.5
	Exp.	"	494.7	151.2	562.4	14.57	5.10	81.92	28.71	113.7	16.6	5.80	372.0	54.2	19.0
	IV. Pre.	No. 4	266.2	83.9	298.3	14.52	5.10	42.58	14.97	110.2	16.0	5.62	349.8	50.8	17.8
	Exp.	"	505.3	165.6	549.9	14.44	5.05	79.44	27.76	108.8	15.7	5.49	332.1	48.0	16.8
	V. Pre.	No. 3	248.7	63.9	280.9	14.43	4.98	40.54	13.99	113.0	16.3	5.63	439.6	63.4	21.9
	Exp.	"	432.5	108.1	450.7	13.97	4.77	62.95	21.48	104.2	14.6	4.97	416.9	58.2	19.9
MONTEREY	II. Pre.	No. 4	236.1	44.2	189.1	13.95	4.67	26.37	8.84	80.1	11.2	3.74	427.9	59.7	20.0
	Exp.	"	475.4	138.3	376.2	14.03	4.71	52.77	17.73	79.1	11.1	3.73	272.0	38.2	12.8
	III. Pre.	No. 3	262.8	84.3	207.4	14.26	4.90	29.57	10.16	78.9	11.3	3.87	246.0	35.1	12.1
	Exp.	"	514.0	165.4	366.7	14.30	4.91	52.45	18.01	71.3	10.2	3.50	221.7	31.7	10.9
	IV. Pre.	No. 4	261.7	82.5	185.3	14.04	4.85	26.02	8.98	70.8	9.9	3.43	224.6	31.5	10.9
	Exp.	"	482.0	145.4	334.0	14.47	4.01	48.34	16.75	69.3	10.0	3.48	229.7	33.3	11.5
JANICE	II. Pre.	No. 2	257.6	76.6	149.1	14.68	4.88	21.89	7.27	57.9	8.5	2.82	194.7	28.6	9.5
	Exp.	"	459.1	150.1	265.8	14.96	5.12	39.77	13.62	57.9	8.7	2.97	177.1	26.5	9.1
	III. Pre.	No. 3	244.1	74.6	136.9	14.97	5.27	20.49	7.22	56.1	8.4	2.96	183.5	27.5	9.7
	Exp.	"	467.5	125.7	261.6	15.03	5.25	39.32	13.73	56.0	8.4	2.94	208.1	31.3	10.9
	IV. Pre.	No. 2	244.5	72.0	127.7	14.88	5.12	19.02	6.54	52.2	7.8	2.68	177.4	26.4	9.1
	Exp.	"	456.3	139.4	241.2	14.98	5.19	36.12	12.51	52.8	7.9	2.74	173.0	25.9	9.0
	V. Pre.	No. 3	251.1	75.3	131.9	15.04	5.29	19.84	6.98	52.5	7.9	2.78	175.2	26.4	9.3
	Exp.	"	430.6	115.7	233.3	15.07	5.42	35.16	12.65	54.2	8.2	2.94	201.6	30.4	10.9
VIVIAN	III. Pre.	No. 3	247.9	84.3	186.7	13.70	4.60	25.58	8.58	75.3	10.3	3.46	221.5	30.3	10.2
	Exp.	"	489.5	166.3	352.4	13.66	4.47	48.12	15.74	72.0	9.8	3.22	211.9	28.9	9.5
	IV. Pre.	"	250.6	84.8	180.5	13.63	4.50	24.61	8.12	72.0	9.8	3.24	212.8	29.0	9.6
	Exp.	"	445.5	153.8	341.7	13.81	4.56	47.18	15.57	76.7	10.6	3.50	222.2	30.7	10.1
	V. Pre.	"	247.1	74.5	186.7	14.21	4.76	26.52	8.88	75.6	10.7	3.59	250.6	35.6	11.9
	Exp.	"	444.5	164.3	315.0	14.34	4.94	45.18	15.57	70.9	10.2	3.50	191.7	27.5	9.5
JUANITA	III. Pre.	No. 2	253.0	85.9	167.3	15.96	6.20	26.71	10.37	66.1	10.6	4.10	194.8	31.1	12.1
	Exp.	"	496.2	153.9	315.7	16.38	6.28	51.72	19.83	63.6	10.4	4.00	205.1	33.6	12.9
	IV. Pre.	No. 3	260.5	82.8	166.3	16.52	6.43	27.47	10.69	63.8	10.5	4.10	200.8	33.2	12.9
	Exp.	"	483.5	160.2	291.0	16.56	6.46	48.18	18.83	60.2	10.0	3.90	181.6	30.1	11.8
	V. Pre.	No. 2	236.2	51.0	141.6	16.27	6.12	23.04	8.69	60.0	9.8	3.68	277.7	45.2	17.0
	Exp.	"	495.3	152.2	211.4	16.50	6.38	34.87	13.49	42.7	7.0	2.72	138.9	22.9	8.9

* In total ration. † In experimental portion of ration.

Name of cow	Low, medium and high feeding — Period numbers	Experimental ration	Dry matter eaten*	Dry matter eaten†	Milk	Total solids	Fat	Total solids	Fat	Weight of products obtained per 100 lbs of dry matter eaten					
										In entire ration			In experimental feed		
										Milk	Total solids	Fat	Milk	Total solids	Fat
			lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
KATRINA	I. Pre.	No. 2	197.8	57.9	115.6	15.18	5.45	17.55	6.30	58.4	8.9	3.19	199.7	30.3	10.9
	Exp.	"	378.2	108.1	210.3	15.38	5.53	32.34	11.64	55.6	8.6	3.08	194.5	29.9	10.8
	II. Pre.	"	202.7	50.5	106.7	15.46	5.61	16.49	5.99	52.6	8.1	2.96	211.3	32.7	11.9
	Exp.	"	365.4	103.4	187.1	15.58	5.72	29.14	10.70	51.2	8.0	2.93	181.0	28.2	10.3
	III. Pre.	"	197.2	54.6	88.2	16.17	6.30	14.26	5.56	44.7	7.2	2.82	161.5	26.1	10.2
	Exp.	"	380.7	100.4	174.5	15.65	5.87	27.31	10.25	45.8	7.2	2.69	173.8	27.2	10.2
	IV. Pre.	"	185.4	43.3	83.3	15.28	5.81	12.73	4.84	44.9	6.9	2.61	192.4	29.4	11.2
	Exp.	"	368.5	95.8	148.0	15.42	5.76	22.83	8.52	40.2	6.2	2.31	154.5	23.8	8.9
BEAUTINA	II. Pre.	No. 2	275.4	86.5	124.6	14.52	5.15	18.07	6.41	45.2	6.6	2.33	144.0	20.9	7.4
	Exp.	"	497.9	165.4	243.1	14.56	5.07	35.39	12.33	48.8	7.1	2.48	147.0	21.4	7.5
	III. Pre.	No. 3	266.3	85.2	127.2	14.69	5.34	18.68	6.80	47.8	7.0	2.55	149.3	21.9	8.0
	Exp.	"	517.8	166.3	232.0	14.88	5.48	34.53	12.72	44.8	6.7	2.46	139.5	20.8	7.7
	IV. Pre.	No. 2	261.9	83.3	112.1	14.87	5.66	16.67	6.34	42.8	6.4	2.42	134.6	20.0	7.6
	Exp.	"	490.2	160.3	207.5	14.92	5.51	30.96	11.44	42.3	6.3	2.33	129.4	19.3	7.1
BERTHA	I. Pre.	No. 2	259.0	86.9	102.3	15.59	5.90	15.95	6.04	39.5	6.2	2.33	117.7	18.4	7.0
	Exp.	"	509.3	164.0	193.1	15.53	5.72	29.97	11.03	37.9	5.9	2.17	117.7	18.3	6.7
	II. Pre.	"	274.6	85.7	93.4	15.69	5.80	14.65	5.42	34.0	5.3	1.97	109.0	17.1	6.3
	Exp.	"	499.8	162.7	152.3	15.80	5.97	24.05	9.09	30.5	4.8	1.82	93.6	14.8	5.6
	III. Pre.	"	252.8	79.7	72.2	15.90	6.25	11.48	4.51	28.6	4.5	1.78	90.6	14.4	5.7
	Exp.	"	490.9	144.0	144.9	15.75	5.98	22.82	8.67	29.5	4.7	1.77	100.6	15.8	6.0
	IV. Pre.	"	264.3	82.2	69.7	15.17	5.65	10.58	3.94	26.4	4.0	1.49	84.8	12.9	4.8
	Exp.	"	486.9	153.3	123.4	15.36	5.84	18.95	7.21	25.3	3.9	1.48	80.5	12.4	4.7
PRIMROSE	III. Pre.	No. 1	267.7	84.1	254.7	13.83	4.58	35.22	11.66	95.2	13.2	4.36	302.9	41.9	13.9
	Exp.	"	509.1	161.6	420.5	13.68	4.53	57.52	19.04	82.6	11.3	3.74	260.2	35.6	11.8
	IV. Pre.	No. 3	263.8	85.6	218.5	13.25	4.25	28.94	9.29	82.8	11.0	3.52	255.3	33.8	10.9
	Exp.	"	488.4	162.9	391.2	13.83	4.70	54.09	18.40	80.1	11.1	3.77	240.2	33.2	11.3
	V. Pre.	No. 1	266.1	85.6	212.4	13.94	4.70	29.61	9.98	79.8	11.1	3.75	248.1	34.6	11.7
	Exp.	"	516.0	165.4	424.3	13.64	4.55	57.86	19.32	82.2	11.2	3.74	256.5	35.0	11.7
ROSEMARY	II. Pre.	No. 1	261.9	84.8	286.0	13.62	4.06	38.96	11.62	109.2	14.9	4.44	337.3	45.9	13.7
	Exp.	"	504.9	162.3	565.3	13.67	4.28	77.24	24.21	112.0	15.3	4.80	348.3	47.6	14.9
	III. Pre.	"	265.8	84.0	262.7	13.76	4.52	36.14	11.86	98.8	13.6	4.46	312.7	43.0	14.1
	Exp.	"	511.7	162.5	483.8	13.77	4.54	66.64	21.97	94.6	13.0	4.29	297.7	41.0	13.5
	IV. Pre.	"	265.3	85.4	245.1	13.84	4.55	33.93	11.16	92.4	12.8	4.21	287.0	39.7	13.1
	Exp.	"	497.0	163.6	467.2	13.82	4.54	64.60	21.20	94.0	13.0	4.27	285.6	39.5	13.0
	V. Pre.	"	271.6	85.4	249.2	13.78	4.53	34.33	11.28	91.7	12.6	4.15	291.8	40.2	13.2
	Exp.	"	535.3	165.4	476.8	13.94	4.59	66.46	21.90	89.1	12.4	4.09	288.3	40.2	13.2
GOLDENROD	II. Pre.	No. 1	327.0	84.4	186.8	16.93	6.45	31.62	12.05	57.1	9.7	3.69	221.3	37.5	14.3
	Exp.	"	596.6	161.4	348.6	17.08	6.60	59.53	22.99	58.4	10.0	3.85	216.0	36.9	14.2
	III. Pre.	No. 3	312.9	85.1	190.9	17.32	7.17	33.07	13.69	61.0	10.8	4.38	224.3	39.8	16.1
	Exp.	"	613.0	165.4	379.2	17.48	7.00	66.29	26.56	61.9	10.8	4.33	229.3	40.1	16.1
	IV. Pre.	No. 1	315.9	81.9	185.5	17.09	6.62	31.70	12.28	58.7	10.0	3.89	226.5	38.7	15.0
	Exp.	"	600.4	162.7	371.1	17.37	6.89	64.44	25.57	61.8	10.7	4.26	228.1	39.6	15.7
	V. Pre.	No. 3	318.1	80.7	194.0	17.08	6.80	33.13	13.20	61.0	10.4	4.15	240.4	41.1	16.4
	Exp.	"	596.3	168.0	385.6	16.87	6.76	65.04	26.06	64.7	10.9	4.37	229.5	38.7	15.5

*** In total ration.   † In experimental portion of ration.**

Name of cow	Nos. 1, 3 and 2 / Period numbers	Experimental ration	Dry matter eaten *	Dry matter eaten †	Milk	Total solids	Fat	Total solids	Fat	Weight of products obtained per 100 lbs. of dry matter eaten: In entire ration: Milk	In entire ration: Total solids	In entire ration: Fat	In experimental feed: Milk	In experimental feed: Total solids	In experimental feed: Fat
			lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
LAVENDER	I. Pre.	No. 1	258.9	85.4	139.0	15.86	6.23	22.04	8.66	53.7	8.5	3.35	162.8	25.8	10.1
	Exp.	"	501.3	163.0	270.6	15.75	6.23	42.61	16.86	54.0	8.5	3.36	166.0	26.1	10.3
	II. Pre.	"	272.5	84.4	131.8	15.87	6.28	20.92	8.27	48.4	7.7	3.04	156.2	24.8	9.8
	Exp.	"	509.1	162.3	244.9	16.08	6.40	39.39	15.66	48.1	7.7	3.08	150.9	24.3	9.6
	III. Pre.	"	265.8	84.0	128.6	16.38	6.70	21.06	8.61	48.4	7.9	3.24	153.1	25.1	10.3
	Exp.	"	508.3	162.5	208.8	16.58	6.55	34.63	13.67	41.1	6.8	2.69	128.5	21.3	8.4
ROSEL	III. Pre.	No. 3	287.9	85.2	221.0	14.74	5.30	32.58	11.71	76.8	11.3	4.07	259.4	38.2	13.7
	Exp.	"	580.1	165.4	412.8	14.68	5.13	60.60	21.18	71.2	10.4	3.65	249.6	36.6	12.8
	IV. Pre.	"	301.3	86.6	213.2	14.82	5.10	31.60	10.87	70.8	10.5	3.61	246.2	36.5	12.6
	Exp.	"	560.3	167.4	390.7	15.35	5.48	59.97	21.42	69.7	10.7	3.82	233.4	35.8	12.8
	V. Pre.	"	300.2	87.3	202.8	15.60	5.50	31.64	11.16	67.6	10.5	3.72	232.3	36.2	12.8
	Exp.	"	581.2	168.9	381.5	15.59	5.54	59.48	21.13	65.6	10.2	3.64	225.9	35.2	12.5
PRETORIA	III. Pre.	No. 3	240.5	64.7	218.9	13.30	4.51	29.12	9.87	91.0	12.1	4.10	338.4	45.0	15.3
	Exp.	"	509.1	162.7	404.6	13.55	4.55	54.82	18.39	79.5	10.8	3.61	248.7	33.7	11.3
	IV. Pre.	"	252.4	80.3	196.2	13.33	4.35	26.15	8.54	77.7	10.4	3.38	244.3	32.6	10.6
	Exp.	"	464.3	137.4	349.2	13.61	4.51	47.51	15.75	75.2	10.2	3.39	254.2	34.6	11.5
	V. Pre.	"	250.2	70.9	170.8	13.67	4.70	23.35	8.03	68.3	9.3	3.21	240.9	32.9	11.3
	Exp.	"	463.8	127.6	306.0	13.43	4.52	41.09	13.83	66.0	8.9	2.98	239.8	32.2	10.8
STAR BRIGHT	I. Pre.	No. 2	260.3	86.9	189.9	15.82	5.85	30.04	11.11	73.0	11.5	4.27	218.5	34.6	12.8
	Exp.	"	511.8	165.8	361.6	15.71	5.72	56.82	20.67	70.7	11.1	4.04	218.1	34.3	12.5
	II. Pre.	No. 1	275.2	84.5	177.8	16.11	6.03	28.64	10.72	64.6	10.4	3.90	210.4	33.9	12.7
	Exp.	"	509.3	161.4	335.5	15.99	5.93	53.64	19.91	65.9	10.5	3.91	207.9	33.2	12.3
	III. Pre.	No. 2	267.0	85.9	181.7	16.09	6.10	29.24	11.08	68.1	11.0	4.15	211.5	34.0	12.9
	Exp.	"	507.5	157.6	330.4	16.06	6.03	53.07	19.93	65.1	10.5	3.93	209.6	33.7	12.6
	IV. Pre.	No. 1	270.0	86.2	180.5	15.59	5.65	28.13	10.20	66.9	10.4	3.78	209.4	32.6	11.8
	Exp.	"	508.9	163.6	345.0	16.09	6.13	55.52	21.15	67.8	10.9	4.16	210.9	33.9	12.9
	V. Pre.	No. 2	267.4	84.1	175.3	15.68	5.88	27.48	10.30	65.6	10.3	3.85	208.4	32.7	12.2
	Exp.	"	487.3	156.6	328.7	15.26	5.70	50.15	18.72	67.5	10.3	3.84	209.9	32.0	12.0
URSULA	I. Pre.	No. 2	302.9	86.9	210.2	15.48	5.77	32.54	12.13	69.4	10.7	4.01	241.9	37.4	14.0
	Exp.	"	564.0	165.8	430.7	15.13	5.41	65.13	23.29	76.4	11.6	4.13	259.8	39.3	14.0
	II. Pre.	"	301.5	86.6	226.9	14.93	5.30	33.87	12.03	75.3	11.2	3.99	262.0	39.1	13.9
	Exp.	"	577.1	165.4	430.6	14.85	5.23	63.95	22.52	74.6	11.1	3.90	260.4	38.7	13.6
	III. Pre.	"	294.7	85.9	216.5	14.97	5.40	32.40	11.69	73.5	11.0	3.97	252.0	37.7	13.6
	Exp.	"	570.6	158.5	388.0	14.80	5.28	57.42	20.49	68.0	10.1	3.59	244.8	36.2	12.9
	IV. Pre.	"	299.6	83.0	196.2	14.87	5.38	29.18	10.56	65.5	9.7	3.52	236.4	35.2	12.7
	Exp.	"	565.1	160.3	381.3	14.92	5.36	56.90	20.45	67.5	10.1	3.62	237.9	35.5	12.8
	V. Pre.	"	305.8	84.0	200.2	15.02	5.33	30.06	10.66	65.5	9.8	3.49	238.3	35.8	12.7
	Exp.	"	600.6	163.8	382.5	14.71	5.23	56.25	19.99	63.7	9.4	3.33	233.5	34.3	12.2
DOROTHY	III. Pre.	No. 1													
	Exp.	"	481.6	144.8	530.2	14.46	4.78	76.69	25.32	110.1	15.9	5.26	366.2	53.0	17.5
	IV. Pre.	No. 2	255.4	75.5	267.9	13.58	4.35	36.37	11.65	104.9	14.2	4.56	354.8	48.2	15.4
	Exp.	"	467.6	144.6	480.0	13.83	4.53	66.38	21.77	102.7	14.2	4.66	332.0	45.9	15.1
	V. Pre.	No. 1	262.9	82.7	234.5	14.04	4.52	32.94	10.61	89.2	12.5	4.04	283.6	39.8	12.8
	Exp.	"	454.0	152.8	375.7	14.08	4.72	52.91	17.75	82.8	11.7	3.91	245.9	34.6	11.6

* In total ration. † In experimental portion of ration.

Name of cow	Nos. 1 and 2, corn and pomace silages — Period numbers	Experimental ration	Dry matter eaten*	Dry matter eaten†	Milk	Total solids	Fat	Total solids	Fat	Weight of products obtained per 100 lbs. of dry matter eaten — In entire ration — Milk	In entire ration — Total solids	In entire ration — Fat	In experimental feed — Milk	In experimental feed — Total solids	In experimental feed — Fat
			lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
EDITH	III. Pre.	No. 1	242.4	84.0	399.0	14.53	5.20	57.98	20.75	164.6	23.9	8.56	475.0	69.0	24.7
	Exp.	"	475.8	161.6	712.3	14.19	4.92	101.05	35.06	149.9	21.3	7.38	440.8	62.5	21.7
	IV. Pre.	"	251.0	85.4	351.9	13.91	4.75	48.96	16.71	140.2	19.5	6.66	412.1	57.3	19.6
	Exp.	"	466.5	163.6	607.0	14.24	4.90	86.45	29.74	130.1	18.6	6.38	371.0	52.8	18.2
	V. Pre.	"	251.5	85.4	306.2	14.44	4.96	44.21	15.01	121.8	17.6	5.97	358.6	51.8	17.6
	Exp.	"	513.6	165.4	572.6	14.17	4.84	81.14	27.69	111.5	15.8	5.39	346.2	49.1	16.7
LORNA DOONE	I. Pre.	No. 1	205.7	63.2	108.1	13.99	4.65	15.12	5.03	52.6	7.4	2.45	171.0	23.9	8.0
	Exp.	"	398.8	117.8	201.4	13.87	4.59	27.93	9.25	50.5	7.0	2.32	171.0	23.7	7.9
	II. Pre.	No. 2	212.5	60.3	100.9	13.88	4.55	14.01	4.59	47.5	6.6	2.16	167.3	23.2	7.6
	Exp.	"	368.8	116.9	169.7	14.46	5.04	24.54	8.55	46.0	6.7	2.32	145.2	21.0	7.3
	III. Pre.	No. 1	203.6	63.1	85.7	14.28	5.05	12.24	4.33	42.1	6.0	2.13	135.8	19.4	6.9
	Exp.	"	405.3	121.9	160.9	14.01	4.80	22.56	7.73	39.7	5.6	1.91	132.0	18.5	6.3
	IV. Pre.	No. 2	214.7	64.1	78.8	14.00	4.80	11.03	3.78	36.7	5.1	1.76	122.9	17.2	5.9
	Exp.	"	402.5	120.9	150.3	14.62	4.92	21.97	7.40	37.3	5.5	1.84	124.3	18.2	6.1
SANTA CLARA	I. Pre.	Pomace	269.8	68.5	164.4	16.54	6.28	27.19	10.32	60.9	10.1	3.83	240.0	39.7	15.1
	Exp.	"	560.0	206.2	312.3	16.26	6.14	50.77	19.16	55.8	9.1	3.42	151.5	24.6	9.3
	II. Pre.	Silage	291.1	99.2	158.9	16.43	6.33	26.11	10.05	54.6	9.0	3.45	160.2	26.3	10.1
	Exp.	"	516.4	182.7	300.5	16.58	6.39	49.83	19.19	58.2	9.7	3.72	164.5	27.3	10.5
	III. Pre.	Pomace	286.9	98.8	161.0	17.41	7.21	28.03	11.61	56.1	9.8	4.05	163.0	28.4	11.8
	Exp.	"	582.4	211.7	329.7	17.34	6.95	57.18	22.90	56.6	9.8	3.93	155.7	27.0	10.8
	IV. Pre.	Silage	281.8	92.1	167.7	17.19	6.67	28.83	11.19	59.5	10.2	3.97	182.1	31.3	12.2
	Exp.	"	520.0	160.1	306.1	17.59	7.07	53.84	21.63	58.9	10.4	4.16	191.3	33.7	13.5
	V. Pre.	Pomace	283.9	103.5	165.4	17.53	7.10	29.00	11.74	58.3	10.2	4.14	160.0	28.0	11.3
	Exp.	"	478.7	172.0	265.7	17.67	7.26	46.96	19.28	55.5	9.8	4.03	154.5	27.3	11.2
M'TA BELLA	I. Pre.	Silage	257.2	51.5	165.1	16.07	6.37	26.53	10.52	64.2	10.3	4.09	320.6	51.5	20.4
	Exp.	"	504.8	115.4	338.3	15.87	6.14	53.69	20.77	67.0	10.6	4.11	293.2	46.5	18.0
	II. Pre.	"	272.4	68.3	180.0	16.08	6.33	28.94	11.39	66.1	10.6	4.18	263.5	42.4	16.7
	Exp.	"	499.4	124.2	347.5	16.13	6.27	56.05	21.79	69.6	11.2	4.36	279.8	45.1	17.5
	III. Pre.	"	264.0	62.3	185.4	16.07	6.51	29.79	12.06	70.2	11.3	4.57	297.6	47.8	19.4
	Exp.	"	513.6	121.4	339.2	16.20	6.44	54.94	21.85	66.0	10.7	4.25	279.4	45.3	18.0
MERMAID	I. Pre.	Silage	264.9	51.1	176.9	17.33	7.28	30.65	12.87	66.8	11.6	4.86	346.2	60.0	25.2
	Exp.	"	513.6	115.4	355.2	17.08	7.03	60.65	24.98	69.2	11.8	4.86	307.8	52.6	21.6
	II. Pre.	Pomace	275.7	68.0	188.3	17.15	7.06	32.30	13.29	68.3	11.7	4.83	276.9	47.5	19.5
	Exp.	"	523.2	129.7	352.8	17.47	7.15	61.63	25.24	67.4	11.8	4.82	272.0	47.5	19.5
	III. Pre.	Silage	268.0	62.9	169.5	17.51	7.40	29.68	12.54	63.2	11.1	4.68	269.5	47.2	19.9
	Exp.	"	513.4	121.4	268.5	17.65	7.32	47.40	19.66	52.3	9.2	3.83	221.0	39.1	16.2
	IV. Pre.	Pomace	275.6	72.5	138.2	17.30	7.20	23.91	9.95	50.2	8.7	3.61	190.6	33.0	13.7
	Exp.	"	525.9	138.0	256.2	17.48	7.14	44.79	18.30	48.7	8.5	3.48	185.7	32.5	13.3

* In total ration. † In experimental portion of ration.

Name of cow	Corn and pomace silages / Period numbers	Experimental ration	Dry matter eaten *	Dry matter eaten †	Milk	Total solids	Fat	Total solids	Fat	Weight of products obtained per 100 lbs. of dry matter eaten: In entire ration: Milk	Total solids	Fat	In experimental feed: Milk	Total solids	Fat
			lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
EVA	I. Pre.	Pomace	276.1	67.6	160.3	18.22	7.80	29.21	12.50	58.1	10.6	4.53	237.1	43.2	18.5
	Exp.	"	590.4	206.2	334.3	17.60	7.03	58.81	23.51	56.6	10.0	3.98	162.1	28.5	11.4
	II. Pre.	"	305.0	99.1	171.4	17.90	7.24	30.68	12.41	56.2	10.1	4.07	173.0	31.0	12.5
	Exp.	"	567.1	189.4	306.9	18.91	8.06	58.04	24.74	54.1	10.2	4.36	162.1	30.6	13.1
	III. Pre.	"	294.2	99.3	150.7	19.04	8.27	28.69	12.47	51.2	9.8	4.24	151.8	28.9	12.6
	Exp.	"	598.2	212.0	249.7	18.80	8.00	46.94	19.99	41.7	7.9	3.34	117.7	22.1	9.4
CERES	II. Pre.	Silage													
	Exp.	"	503.0	124.2	620.8	14.31	4.77	88.83	29.63	123.4	17.7	5.89	499.8	71.5	23.9
	III. Pre.	Pomace	249.1	79.5	309.6	14.33	5.04	44.36	15.59	124.3	17.8	6.26	389.4	55.8	19.6
	Exp.	"	567.5	174.0	633.1	14.59	5.08	92.35	32.18	111.6	16.3	5.67	363.8	53.1	18.5
	IV. Pre.	Silage	261.9	73.7	290.5	14.32	4.97	41.60	14.44	110.9	15.9	5.51	394.2	56.4	19.6
	Exp.	"	536.8	140.8	586.5	14.62	5.13	85.75	30.10	109.3	16.0	5.61	416.1	60.8	21.4
	V. Pre.	Pomace	296.4	90.2	303.6	14.61	5.10	44.35	15.48	102.4	15.0	5.22	336.6	49.2	17.2
	Exp.	"	554.0	164.0	549.7	14.31	5.01	78.67	27.52	99.2	14.2	4.97	335.1	47.9	16.8
SANTA ROSA	II. Pre.	Silage	251.1	67.8	166.4	13.65	4.48	22.71	7.46	66.3	9.0	2.97	245.5	33.5	11.0
	Exp.	"	488.6	124.0	356.0	13.80	4.47	49.12	15.91	72.9	10.1	3.26	287.1	39.6	12.8
	III. Pre.	Pomace	238.3	64.2	181.3	14.04	4.75	25.46	8.62	76.1	10.7	3.62	282.4	39.7	13.4
	Exp.	"	538.3	145.7	398.5	14.07	4.63	56.07	18.43	74.0	10.4	3.42	273.5	38.5	12.6
	IV. Pre.	Silage	267.5	63.7	201.4	13.83	4.42	27.86	8.91	75.3	10.4	3.33	316.2	43.7	14.0
	Exp.	"	505.0	112.4	380.8	14.28	4.72	54.39	17.97	75.4	10.8	3.56	338.8	48.4	16.0
	V. Pre.	Pomace	277.2	71.9	183.6	14.43	4.85	26.49	8.90	66.2	9.6	3.21	255.4	36.8	12.4
	Exp.	"	504.9	125.6	300.0	14.68	4.95	44.03	14.86	59.4	8.7	2.94	238.9	35.1	11.8
YUBA	II. Pre.	Silage	234.0	67.3	160.2	14.48	4.96	23.20	7.95	68.5	9.9	3.40	238.0	34.5	11.8
	Exp.	"	498.8	124.2	335.7	14.84	5.19	49.81	17.42	67.3	10.0	3.49	270.3	40.1	14.0
	III. Pre.	Pomace	266.1	65.8	181.6	15.29	5.67	27.77	10.29	68.2	10.4	3.87	276.0	42.2	15.6
	Exp.	"	538.2	144.7	365.7	15.16	5.49	55.44	20.07	68.0	10.3	3.73	252.7	38.3	13.9
	IV. Pre.	Silage	269.5	63.9	184.5	15.06	5.32	27.79	9.82	68.5	10.3	3.64	288.7	43.5	15.4
	Exp.	"	506.9	112.6	341.4	15.23	5.54	51.99	18.91	67.4	10.3	3.73	303.2	46.2	16.8
	V. Pre.	Pomace	278.8	72.6	179.9	15.40	5.65	27.71	10.16	64.5	9.9	3.64	247.8	38.2	14.0
	Exp.	"	495.9	121.0	325.1	15.29	5.69	49.70	18.51	65.6	10.0	3.73	268.7	41.1	15.3
NAOMI	II. Pre.	Pomace	270.3	66.9	201.3	14.72	4.80	29.63	9.66	74.5	11.0	3.57	300.9	44.3	14.4
	Exp.	"	492.9	117.7	425.8	14.65	4.77	62.36	20.30	86.4	12.7	4.12	361.8	53.0	17.2
	III. Pre.	Silage	253.4	56.8	211.0	14.50	4.71	30.60	9.93	83.3	12.1	3.92	371.5	58.9	17.5
	Exp.	"	487.4	107.4	419.3	14.79	4.90	62.02	20.53	86.0	12.7	4.21	390.4	57.7	19.1
	IV. Pre.	Pomace	258.2	54.6	212.5	14.48	4.80	30.77	10.19	82.3	11.9	3.95	389.2	56.4	18.7
	Exp.	"	464.2	91.7	366.3	14.84	5.00	54.36	18.32	78.9	11.7	3.95	399.5	59.3	20.0

* In total ration. † In experimental portion of ration.

Name of cow	Pomace and pumpkins / Period numbers	Experimental ration	Dry matter eaten *	Dry matten eaten †	Milk	Total solids	Fat	Total solids	Fat	Weight of products obtained per 100 lbs. of dry matter eaten: In entire ration: Milk	In entire ration: Total solids	In entire ration: Fat	In experimental feed: Milk	In experimental feed: Total solids	In experimental feed: Fat
			lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
ACME	I. Pre.	Pomace	323.9		211.7	11.91	3.75	25.21	7.94	65.4	7.8	2.45			
	Exp.	“	592.5	56.1	453.8	12.08	3.80	54.82	17.24	76.6	9.3	2.91	809.9	97.7	30.7
	II. Pre.	P'mpk's	274.3	63.0	226.1	12.27	3.85	27.73	8.70	82.4	10.1	3.17	358.9	44.0	13.8
	Exp.	“	552.5	135.7	457.2	11.97	3.72	54.70	16.99	82.7	9.9	3.08	336.9	40.3	12.5
	III. Pre.	Pomace	301.5	28.3	218.0	12.04	3.77	26.25	8.22	72.3	8.7	2.73	770.4	92.8	29.0
	Exp.	“	565.3	54.1	406.1	11.75	3.60	47.70	14.61	71.8	8.4	2.58	750.7	88.2	27.0
	IV. Pre.	“	307.9	28.4	199.5	11.93	3.75	23.80	7.48	64.8	7.7	2.43	702.4	83.8	26.3
	Exp.	“	609.3	60.7	397.4	11.84	3.70	47.04	14.69	65.2	7.7	2.41	654.7	77.5	24.2
	V. Pre.	“	317.4	30.2	194.3	11.78	3.67	22.89	7.14	61.2	7.2	2.25	643.4	75.8	23.6
	Exp.	“	595.4	57.5	328.3	11.66	3.66	38.27	12.01	55.1	6.4	2.02	571.0	66.6	20.9
NANCY B	I. Pre.	Pomace	303.9		198.9	12.04	3.75	23.95	7.46	65.4	7.9	2.45			
	Exp.	“	569.0	56.1	406.8	12.38	3.80	50.36	15.46	71.5	8.9	2.72	725.2	89.8	27.6
	II. Pre.	P'mpk's	270.7	63.0	213.9	12.72	3.77	27.20	8.07	79.0	10.0	2.98	339.5	43.2	12.8
	Exp.	“	547.0	140.6	442.0	12.44	3.85	55.00	17.01	80.8	10.1	3.11	314.4	39.1	12.1
	III. Pre.	Pomace	299.7	28.3	218.2	12.58	3.80	27.45	8.29	72.8	9.2	2.77	771.0	97.0	29.3
	Exp.	“	559.5	54.1	398.3	12.78	4.01	50.89	15.97	71.2	9.1	2.85	736.2	94.1	29.5
	IV. Pre.	“	303.7	28.4	218.6	12.84	4.03	28.06	8.80	72.0	9.2	2.90	769.8	98.8	31.0
	Exp.	“	604.2	60.7	468.1	12.82	3.93	60.01	18.40	77.5	9.9	3.05	771.2	98.9	30.3
	V. Pre.	“	317.4	30.2	225.1	12.80	4.01	28.82	9.02	70.9	9.1	2.84	745.4	95.4	29.9
	Exp.	“	598.8	57.5	410.0	12.85	3.97	52.67	16.29	68.5	8.8	2.72	713.1	91.6	28.3
HALLOWE'EN	I. Pre.	Pomace	316.9		131.8	15.05	5.60	19.84	7.38	41.6	6.3	2.33			
	Exp.	“	556.8	56.1	283.6	15.24	5.60	43.22	15.88	50.9	7.8	2.85	505.6	77.0	28.3
	II. Pre.	P'mpk's	272.5	63.0	160.4	15.33	5.67	24.59	9.10	58.9	9.0	3.34	254.6	39.0	14.4
	Exp.	“	544.5	140.6	314.2	15.31	5.75	48.09	18.06	57.7	8.8	3.32	223.5	34.2	12.8
	III. Pre.	Pomace	313.5	28.3	148.5	15.12	5.52	22.45	8.20	47.4	7.2	2.62	524.8	79.3	29.0
	Exp.	“	586.1	54.1	279.5	15.34	5.73	42.87	16.01	47.7	7.3	2.73	516.7	79.2	29.6
	IV. Pre.	“	306.6	28.4	135.6	15.74	6.10	21.34	8.27	44.2	7.0	2.70	477.5	75.1	29.1
	Exp.	“	596.4	59.4	250.6	15.64	5.96	39.18	14.93	42.0	6.6	2.50	421.9	66.0	25.1
	V. Pre.	“	300.3	27.0	119.7	15.56	5.94	18.63	7.11	39.9	6.2	2.37	443.3	69.0	26.3
	Exp.	“	580.0	57.5	226.9	15.38	5.92	34.89	13.44	39.1	6.0	2.32	394.6	60.7	23.4
MONA	I. Pre.	Pomace	305.6		149.5	14.48	5.08	21.65	7.59	48.9	7.1	2.48			
	Exp.	“	578.6	56.1	298.1	14.34	4.95	42.75	14.36	51.5	7.4	2.55	531.2	76.2	26.3
	II. Pre.	P'mpk's	266.9	56.6	139.8	14.83	5.32	20.73	7.44	52.4	7.8	2.79	247.4	36.7	13.2
	Exp.	“	548.7	131.9	263.8	14.60	5.19	38.50	13.69	48.1	7.0	2.50	200.0	29.2	10.4
	III. Pre.	Pomace	305.8	28.3	131.2	14.73	5.27	19.32	6.92	42.9	6.3	2.26	463.6	68.3	24.5
	Exp.	“	574.5	54.1	254.9	14.85	5.41	37.86	13.78	44.4	6.6	2.40	471.2	70.0	25.5
	IV. Pre.	“	309.7	27.7	130.9	15.03	5.77	19.68	7.55	42.3	6.4	2.44	472.5	71.1	27.3
	Exp.	“	609.1	60.5	269.1	15.12	5.56	40.69	14.95	44.2	6.7	2.45	444.7	67.3	24.7
	V. Pre.	“	314.8	30.2	136.8	15.27	5.80	20.89	7.94	43.5	6.6	2.52	453.0	69.2	26.3
	Exp.	“	604.9	57.8	244.2	15.34	5.72	37.46	13.96	40.4	6.2	2.31	422.5	64.8	24.2

* In total ration. † In experimental portion of ration.

Name of cow	Nos. 1, 3 and 5 — Period numbers	Experimental ration	Dry matter eaten *	Dry matter eaten †	Milk	Total solids	Fat	Total solids	Fat	Weight of products obtained per 100 lbs. of dry matter eaten — In entire ration: Milk	Total solids	Fat	In experimental feed: Milk	Total solids	Fat
			lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
POWELLA	I. Pre.	No. 5	258.5	81.3	95.8	17.91	7.85	171.6	7.52	37.1	6.6	2.91	117.8	21.1	9.3
	Exp.	"	498.5	162.0	198.1	16.64	6.80	329.6	13.48	39.7	6.6	2.70	122.3	20.3	8.3
	II. Pre.	"	264.4	82.8	99.6	16.96	6.96	168.9	6.93	37.7	6.4	2.62	120.3	20.4	8.4
	Exp.	"	493.1	158.2	171.7	17.01	6.99	292.0	11.99	34.8	5.9	2.43	108.5	18.5	7.6
	III. Pre.	"	254.6	84.5	79.1	16.28	6.89	128.8	5.45	31.1	5.1	2.14	93.6	15.2	6.5
	Exp.	"	498.6	160.4	144.3	16.77	7.04	242.0	10.16	28.9	4.9	2.04	90.0	15.1	6.3
	IV. Pre.	"	253.6	82.2	87.1	16.07	6.60	139.9	5.75	34.4	5.5	2.27	106.0	17.0	7.0
	Exp.	"	479.3	155.8	169.5	16.33	6.55	276.8	11.10	35.4	5.8	2.32	108.8	17.8	7.1
	V. Pre.	"	261.9	79.6	98.0	15.65	6.07	153.4	5.95	37.4	5.9	2.27	123.1	19.3	7.5
	Exp.	"	503.7	151.1	201.7	15.87	6.25	320.0	12.61	40.0	6.4	2.50	133.5	21.2	8.3
UNA	I. Pre.	No. 1	207.4	64.1	117.5	16.57	6.67	194.7	7.84	56.7	9.4	3.78	183.3	30.4	12.2
	Exp.	"	394.3	118.7	222.6	16.46	6.45	366.5	14.36	56.5	9.3	3.64	187.5	30.9	12.1
	II. Pre.	"	201.4	44.0	113.6	16.58	6.53	188.4	7.42	56.4	9.4	3.68	258.2	42.8	16.9
	Exp.	"	396.5	119.1	219.6	17.03	6.87	374.0	15.09	55.4	9.4	3.81	184.4	31.4	12.7
	III. Pre.	"	213.2	63.0	111.3	17.14	7.20	190.8	8.01	52.2	9.0	3.76	176.7	30.3	12.7
	Exp.	"	413.4	121.9	202.4	17.28	7.16	349.7	14.48	49.0	8.5	3.50	166.0	28.7	11.9
DAHLIA	I. Pre.	No. 1	244.4	81.0	138.7	15.44	5.90	214.2	8.18	56.8	8.8	3.35	171.2	26.4	10.1
	Exp.	"	473.1	144.4	257.3	15.55	5.95	400.0	15.30	54.4	8.5	3.23	178.2	27.7	10.6
	II. Pre.	No. 3	265.1	81.9	135.2	15.89	6.20	214.8	8.38	51.0	8.1	3.16	165.1	26.2	10.2
	Exp.	"	469.8	163.2	232.3	15.63	5.89	363.1	13.69	49.4	7.7	2.91	142.3	22.3	8.4
	III. Pre.	No. 1	242.5	77.1	137.6	15.79	6.08	217.3	8.36	56.7	9.0	3.45	178.5	28.2	10.8
	Exp.	"	481.5	152.8	249.3	15.88	6.15	395.8	15.33	51.8	8.2	3.18	163.2	25.9	10.0

* In total ration. † In experimental portion of ration.

VI. DIFFERENCE TABLES. (*a*) TOTALS OF DIFFERENCES; (*b*) PERCENTAGE DIFFERENCES

[Showing differences in experimental feeding between the average of the results of two periods on one ration (the second named in the following tables) and those actually obtained with another ration (the first named in the following tables) in the intervening period.]

(*a*) TOTALS OF DIFFERENCES

RATIONS	Periods represented	Total dry matter eaten	Dry matter eaten in experimental feed	Milk	Total solids	Fat	Total solids	Fat	Weight of products obtained per 100 lbs. of dry matter					
									In entire ration			In experimental feed		
									Milk	Total solids	Fat	Milk	Total solids	Fat
		lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
NO. 2														
Low to very low	3	−109.5	−118.8	−70.0	−0.08	−0.23	−10.29	−4.26	+6.3	+0.7	+0.10	+1262.7	+174.4	+58.9
Very low to low	3	+78.8	+116.0	+113.1	+0.48	+0.27	+18.15	+6.76	+10.4	+1.9	+0.76	−1145.6	−164.7	−57.2
Med. to very low	3	−342.4	−350.6	−190.6	−1.00	−0.60	−31.89	−12.31	+19.2	+2.0	+0.48	+1674.8	+242.9	+85.3
Very low to med.	3	+299.8	+347.3	+156.8	+1.27	+0.67	+28.20	+10.99	−18.2	−1.7	−0.41	−1751.4	−256.0	−91.3
Very low..........	3	+8.3	−0.9	+23.3	−0.01	−0.07	+2.85	+0.55	+7.9	+0.9	+0.21	+79.3	+9.4	+2.2
Low................	3	−5.0	−1.1	+88.8	−0.17	−0.06	+11.75	+3.86	+21.9	+2.9	+0.94	+114.0	+15.0	+5.0
Medium...........	3	+5.9	+1.1	−4.4	+0.42	+0.16	+0.97	+0.45	−1.8	.0	+0.05	−4.3	+0.3	+0.1
NO. 3														
Low to very low	1	−59.8	−42.0	−35.0	−0.01	−0.17	−5.30	−2.72	+5.4	+0.8	+0.12	+457.0	+68.4	+23.8
Very low to low	1	+30.3	+40.0	+25.3	+0.45	+0.30	+5.17	+2.32	−1.7	+0.2	+0.27	−371.9	−48.4	−15.3
Med. to very low	1	−113.3	−105.1	−69.6	−0.28	−0.22	−11.07	−4.25	+11.5	+1.2	+0.27	+748.6	+101.0	+31.8
Very low..........	2	−24.7	.0	+0.4	+0.02	−0.17	+0.29	−0.34	+4.1	+0.6	+0.12	+0.2	+0.5	−0.9
No. 3 to No. 4.....	1	−14.5	+1.7	+14.1	+0.13	+0.08	+2.67	+1.12	+5.7	+0.9	+0.35	+7.2	+1.4	+0.6
No. 4 to No. 3.....	3	+101.8	+65.2	+70.6	+0.08	+0.06	+10.47	+3.69	−4.8	−0.7	−0.18	−93.2	−13.0	−4.5
No. 4 to No. 4.....	3	−1.1	+7.3	−89.9	+0.03	−0.08	−12.63	−4.38	−17.9	−2.6	−0.87	−85.2	−12.0	−4.0
No. 2 to No. 3.....	3	+20.2	−8.6	+42.2	+0.32	+0.41	+7.60	+3.67	+6.8	+1.4	+0.67	+43.9	+7.3	+3.1
No. 3 to No. 2.....	1	+7.2	+18.7	−6.3	−0.07	−0.15	−1.12	−0.68	−2.3	−0.4	−0.20	−31.9	−5.0	−1.9
No. 2 to No. 2.....	4	−3.2	−5.4	−8.0	+0.54	+0.34	−0.40	+0.15	−1.0	.0	+0.08	+0.7	+0.7	+0.4
No. 3 to No. 3.....	1	−21.5	−11.5	+8.0	−0.19	−0.15	+0.53	−0.09	+5.2	+0.6	+0.14	+20.4	+2.5	+0.6
No. 1 to No. 3.....	2	−9.7	+2.6	−11.9	+0.42	+0.41	+0.70	+1.50	−0.5	+0.2	+0.30	−11.0	−0.3	+0.6
No. 3 to No. 1.....	1	−4.3	−4.0	−11.3	+0.19	+0.01	−1.23	−0.74	−1.5	−0.2	−0.09	−1.3	+0.2	−0.1
No. 1 to No. 1.....	3	−11.5	−1.4	−40.4	−0.11	+0.11	−5.46	−1.09	−5.8	−0.9	−0.12	−23.1	−3.1	−0.7
No. 3 to No. 3.....	2	−42.6	−7.6	−13.6	+0.33	+0.11	−0.52	−0.10	+3.7	+0.7	+0.26	+5.5	+1.5	+0.5
No. 1 to No. 2.....	3	−35.1	−12.1	+5.6	+0.10	+0.12	−0.64	−0.31	+5.3	+0.6	+0.16	+19.8	+2.1	+0.7
No. 2 to No. 1.....	3	+30.7	+9.2	+5.8	0	+0.13	+1.90	+1.18	−2.5	−0.3	+0.02	−7.7	−0.9	−0.1
No. 1 to No. 1.....	2	−35.4	−1.1	−28.4	+0.22	+0.08	+3.06	−0.97	+2.0	+0.5	+0.23	−14.9	−1.4	−0.3
No. 2 to No. 2.....	3	−11.2	−2.1	−0.8	−0.05	−0.04	−0.28	−0.16	+0.9	.0	+0.08	+2.3	+0.2	.0
No. 1 to No. 3.....	1	−7.5	−14.6	−21.0	−0.10	−0.16	−3.48	−1.63	−3.7	−0.7	−0.30	−28.4	−4.5	−1.9
Ap. pom. to corn	7	−119.6	−139.7	−2.3	+0.14	−0.06	−0.53	−1.00	+ ...	+2.1	0.74	+240.6	+37.0	+13.4
Corn to ap. pom.	5	+198.3	+146.9	+154.2	+0.62	+0.47	+26.85	+11.11	+0.2	+0.5	+0.51	−182.4	−25.4	−8.1
Pomace to pom'e	5	+59.4	−1.8	+125.9	+1.14	+0.67	+20.77	+7.92	+14.6	+2.6	+1.13	+26.5	+7.1	+2.3
Corn to corn.....	1	−9.8	+5.8	+8.7	+0.09	−0.02	+1.73	+0.48	+3.1	+0.5	+0.18	−6.5	−0.8	−0.5
Hay, &c. to pum's	4	−98.6	......	+91.5	−0.07	+0.05	+11.04	+3.88	+26.2	+3.3	+1.16	....	....	......
No. 5 to No. 5.....	3	−15.0	+0.4	−29.3	+0.41	+0.24	−4.04	−1.50	−4.8	−0.8	−0.23	−19.4	−2.7	−1.3

(b) PERCENTAGE DIFFERENCES

RATIONS	Periods represented	Total dry matter eaten	Total dry matter in experimental feed	Milk	Total solids	Fat	Total solids	Fat	Weight of products obtained per 100 lbs. of dry matter: In entire ration: Milk	In entire ration: Total solids	In entire ration: Fat	In experimental feed: Milk	In experimental feed: Total solids	In experimental feed: Fat
No. 2														
Low to very low	3	− 8	− 50	− 6	0	−2	− 6	− 8	+ 2	+ 2	+ 1	+ 86	+ 85	+ 83
Very low to low	3	+ 6	+ 95	+11	+1	+2	+12	+13	+ 4	+ 6	+ 6	− 42	− 43	− 42
Medium to very low	3	−23	− 74	−16	−2	−4	−18	−20	+ 8	+ 5	+ 4	+227	+220	+215
Very low to medium	3	+25	+289	+16	+3	+4	+19	+21	− 7	− 4	− 3	− 70	− 70	− 69
Very low	3	− 1	− 1	+ 2	0	−1	+ 2	+ 1	+ 3	+ 2	+ 2	+ 3	+ 2	+ 2
Low	3	− 1	− 1	+ 9	0	0	+ 8	+ 8	+ 9	+ 8	+ 8	+ 9	+ 9	+ 8
Medium	3	+ 1	0	− 1	+1	+1	+ 1	+ 1	− 1	0	0	− 1	0	+ 1
No. 3														
Low to very low	1	−13	− 50	− 8	0	−3	− 8	−11	+ 6	+ 6	+ 2	+ 84	+ 84	+ 79
Very low to low	1	+10	+100	+ 8	+3	+7	+12	+16	− 2	+ 1	+ 6	− 46	− 44	− 42
Medium to very low	1	−22	− 72	−13	−2	−5	−15	−17	+11	+ 8	+ 6	+207	+200	+192
Very low	2	− 3	0	0	0	−2	+ 1	− 2	+ 4	+ 3	+ 2	0	+ 1	− 2
No. 3 to No. 4	1	− 3	+ 1	+ 3	+1	+2	+ 4	+ 5	+ 6	+ 7	+ 9	+ 3	+ 4	+ 5
No. 4 to No. 3	3	+ 7	+ 16	+ 5	0	0	+ 5	+ 6	− 2	− 2	− 2	− 10	− 9	− 9
No. 4 to No. 4	3	0	+ 2	− 6	−0	−1	− 6	− 6	− 5	− 6	− 6	− 7	− 7	7
No. 2 to No. 3	3	+ 2	− 2	+ 5	+1	+3	+ 6	+ 8	+ 4	+ 5	+ 7	+ 9	+ 9	+ 11
No. 3 to No. 2	1	+ 2	+ 15	− 3	0	−3	− 3	− 5	− 4	− 5	− 7	− 16	− 16	− 17
No. 2 to No. 2	4	0	− 1	− 1	+1	+1	0	+ 1	− 1	0	+ 1	+ 1	+ 2	+ 2
No. 3 to No. 3	1	− 5	− 7	+ 2	−1	−3	+ 1	− 1	+ 7	+ 6	+ 4	+ 10	+ 9	+ 6
No. 1 to No. 3	2	− 2	+ 1	− 1	+1	+4	+ 1	+ 3	0	+ 1	+ 4	− 2	− 1	+ 2
No. 3 to No. 1	1	− 1	− 2	− 3	+1	0	− 2	− 3	− 2	− 2	− 2	− 1	+ 1	− 1
No. 1 to No. 1	3	− 1	0	− 2	0	+1	− 2	− 1	− 2	− 2	− 1	− 2	− 2	− 1
No. 3 to No. 3	2	− 4	− 3	− 2	+1	+1	− 1	− 1	+ 3	+ 4	+ 4	+ 1	+ 3	+ 3
No. 1 to No. 2	3	− 3	− 3	− 1	0	+1	+ 1	0	+ 2	+ 2	+ 3	+ 1	+ 2	+ 2
No. 2 to No. 1	3	+ 2	+ 2	+ 1	0	0	+ 1	+ 1	− 2	− 2	− 1	− 1	− 2	− 1
No. 1 to No. 1	2	− 4	− 1	− 2	+1	+1	− 2	− 1	+ 2	+ 3	+ 3	− 1	− 1	0
No. 2 to No. 2	3	− 1	− 1	0	0	0	0	0	0	0	0	0	0	0
No. 1 to No. 3	1	− 2	+ 10	− 8	−1	−3	− 9	−11	− 7	− 8	− 9	− 16	− 17	− 18
Apple pomace to corn	7	− 3	− 12	0	0	0	0	0	+ 3	+ 3	+ 3	+ 13	+ 13	+ 13
Corn to apple pomace	5	+ 8	+ 22	+ 9	+1	+2	+ 9	+10	+ 1	+ 1	+ 3	− 11	− 10	− 10
Pomace to pomace	5	+ 2	+ 0	+ 7	+1	+2	+ 9	+ 9	+ 5	+ 6	+ 7	+ 2	+ 3	+ 4
Corn to corn	1	− 2	+ 5	+ 3	+1	0	+ 3	+ 2	+ 5	+ 5	+ 4	− 2	− 2	− 3
Hay to pumpkins	4	− 5	..	+ 6	0	−1	+ 6	+ 6	+10	+10	+11	...	...	...
No. 5 to No. 5	3	− 1	0	− 6	+1	+1	− 5	− 4	− 5	− 4	− 3	− 6	− 5	− 6

VII. RESULTS OF EXPERIMENTAL FEEDING ON DIFFERENT RATIONS

LOW, MEDIUM AND HIGH GRAIN FEEDING

RATIONS	Total dry matter eaten	Dry matter eaten in experimental feed	Milk	Total solids	Fat	Total solids	Fat	Weight of products obtained per 100 lbs. of dry matter: In entire ration: Milk	In entire ration: Total solids	In entire ration: Fat	In experimental feed: Milk	In experimental feed: Total solids	In experimental feed: Fat	Ratio of percent of fat to percent of solids-not-fat
	lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
GRAIN FEED NO. 2. 138 days on each ration														
Low..................	2802	478	2318	14.50	5.08	336.15	117.70	83.5	12.1	4.22	486.1	70.5	24.7	1.86
Very low..........	2614	243	2135	14.40	5.00	307.71	106.68	82.8	11.9	4.11	880.8	127.0	44.1	1.88
Very low ± low...	−188	−235	−183	−0.10	−0.08	−28.44	−11.02	− 0.7	−0.2	−0.11	+394.7	+ 56.5	+19.4	+0.02
% differences.......	− 7	− 49	− 8	− 1	− 2	− 8	− 9	− 1	− 2	− 3	+ 81	+ 80	+ 79	+ 1
GRAIN FEED NO. 2. 138 days on each ration														
Medium............	3025	939	2321	15.12	5.47	350.66	126.72	76.8	11.6	4.19	246.2	37.2	13.5	1.76
Very low...........	2383	241	1973	14.74	5.26	290.57	103.42	83.0	12.2	4.34	817.2	120.4	42.9	1.80
Very low ± med'm	−642	−698	−348	−0.38	−0.21	−60.09	−23.30	+ 6.2	+0.6	+0.15	+571.0	+ 83.2	+29.4	+0.04
% differences.......	− 21	− 74	− 15	− 3	− 4	− 17	− 18	+ 8	+ 5	+ 4	+ 232	+ 224	+ 218	+ 2
GRAIN FEED NO. 3. 46 days on each ration														
Low..................	809	164	805	14.54	5.22	117.52	42.41	100.3	14.6	5.22	490.3	71.5	25.8	1.79
Very low...........	719	82	745	14.31	4.98	107.05	37.37	103.8	14.9	5.15	904.8	129.9	45.3	1.87
Very low ± low...	− 90	− 82	− 60	−0.23	−0.24	−10.47	− 5.04	+ 3.5	+0.3	−0.07	+414.5	+ 58.4	+19.5	+0.08
% differences.......	− 11	− 50	− 7	− 2	− 5	− 9	− 12	+ 3	+ 2	− 1	+ 82	+ 82	+ 75	+ 4
GRAIN FEED NO. 3. 23 days on each ration														
Medium............	525	147	535	13.93	4.58	74.51	24.52	101.4	14.2	4.65	361.4	50.4	16.6	2.04
Very low...........	412	42	465	13.65	4.36	63.44	20.27	112.9	15.4	4.92	1110.0	151.4	48.4	2.13
Very low ± med'm	−113	−105	− 70	−0.28	−0.22	−11.07	− 4.25	+11.5	+1.2	+0.27	+748.6	+101.0	+19.2	+0.09
% differences.......	− 22	− 72	− 13	− 2	− 5	− 15	− 17	+ 11	+ 8	+ 6	+ 207	+ 200	+ 192	+ 4
GRAIN FEED NO. 2. 69 days on each ration														
Very low I.........	1236	120	1299	12.25	3.61	159.18	46.92	105.1	12.9	3.80	1080.9	132.5	39.0	2.40
Very low II........	1205	121	1249	12.19	3.53	152.37	44.09	103.7	12.7	3.66	1034.0	126.1	36.5	2.45
II ± I...............	− 31	+ 1	− 50	−0.06	−0.08	− 6.81	− 2.83	− 1.4	−0.2	−0.14	− 46.9	− 6.4	− 2.5	+0.05
% differences.......	− 3	− 1	− 4	0	− 2	− 4	− 6	− 1	− 2	− 4	− 4	− 5	− 6	+ 2
GRAIN FEED NO. 2. 69 days on each ration														
Low I...............	1258	241	1147	13.94	4.71	159.93	54.15	91.3	12.8	4.31	477.7	66.6	22.6	1.96
Low II..............	1250	244	1165	13.93	4.72	162.24	54.99	93.2	13.0	4.40	476.8	66.5	22.5	1.95
II ± I...............	− 8	+ 3	+ 18	−0.01	+0.01	+ 2.31	+ 0.84	+ 1.9	+0.2	+0.09	− 0.9	− 0.1	− 0.1	−0.01
% differences.......	− 1	+ 1	+ 2	0	0	+ 1	+ 2	+ 2	+ 2	+ 2	0	0	0	− 1

RATIONS	Total dry matter eaten	Dry matter eaten in experimental feed	Milk	Total solids	Fat	Total solids	Fat	Weight of products obtained per 100 lbs. of dry matter: In entire ration: Milk	Total solids	Fat	In experimental feed: Milk	Total solids	Fat	Ratio of percent of fat to percent of solids-not-fat
	lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
GRAIN FEED NO. 2. 69 days on each ration														
Medium I	1506	475	1143	15.64	5.75	178.66	65.64	75.9	11.9	4.35	240.4	37.6	13.8	1.72
Medium II	1497	489	1150	15.61	5.64	179.55	64.79	76.9	12.0	4.33	235.2	36.7	13.3	1.77
II ± I	− 9	+ 14	+ 7	−0.03	−0.11	+ 0.89	− 0.85	+ 1.0	+0.1	−0.02	− 5.2	− 0.9	− 0.5	+0.05
% differences	− 1	+ 3	+ 1	0	+ 2	+ 0	− 1	+ 1	+ 1	0	− 2	− 2	− 4	+ 3
GRAIN FEED NO. 3. 46 days on each ration														
Very low I	829	84	610	14.29	4.91	87.92	30.60	73.0	10.6	3.65	72.79	105.0	36.6	1.91
Very low II	833	84	605	14.39	4.97	87.81	30.64	72.5	10.6	3.67	72.20	104.8	36.6	1.90
II ± I	+ 4	0	− 5	+0.10	+0.06	− 0.11	+ 0.04	− 0.5	0	+0.02	− 5.9	− 0.2	0	−0.01
% differences	0	0	− 1	+ 1	+ 1	0	0	− 1	0	+ 1	− 1	0	0	− 1
GRAIN FEEDS NOS. 3 AND 4. 92 days on each ration														
No. 3	2040	650	1864	14.12	4.78	263.08	89.00	91.4	12.9	4.37	286.2	40.4	13.7	1.95
No. 4	1933	587	1807	14.13	4.79	255.28	86.43	94.5	13.3	4.50	311.3	44.0	15.0	1.95
No. 4 ± No. 3	−107	− 63	− 57	+0.01	+0.01	− 7.80	− 2.57	+ 3.1	+0.4	+0.13	+ 25.1	+ 3.6	+ 1.3	0
% differences	− 5	− 10	− 3	0	0	− 3	− 3	+ 3	+ 3	+ 3	+ 9	+ 9	+ 9	0
GRAIN FEED NO. 4. 69 days on each ration														
No. 4 I	1540	435	1549	13.92	4.59	215.41	70.89	100.8	14.0	4.62	358.0	49.8	16.4	2.03
No. 4 II	1529	454	1504	13.76	4.38	206.78	65.73	98.4	13.5	4.30	331.4	45.6	14.5	2.14
II ± I	− 11	+ 19	− 45	−0.16	−0.21	− 8.63	− 5.16	− 2.4	−0.5	−0.32	− 26.6	− 4.2	− 1.9	+0.11
% differences	− 1	+ 4	− 3	− 1	− 4	− 4	− 7	− 2	− 4	− 7	− 7	− 8	− 12	+ 5
GRAIN FEEDS NOS. 2 AND 3. 92 days on each ration														
No. 2	1904	600	984	15.28	5.49	150.55	54.12	51.8	7.9	2.84	164.6	25.2	9.1	1.78
No. 3	1918	573	1032	15.38	5.63	159.27	58.47	54.0	8.4	3.06	183.5	28.3	10.3	1.73
No. 3 ± No. 2	+ 14	− 27	+ 48	+0.10	+0.14	+ 8.72	+ 4.35	+ 2.2	+0.5	+0.22	+ 18.9	+ 3.1	+ 1.2	−0.05
% differences	+ 1	− 5	+ 5	+ 1	+ 3	+ 6	+ 8	+ 4	+ 6	+ 8	+ 12	+ 12	+ 13	− 3
GRAIN FEED NO. 2. 92 days on each ration														
No. 2 I	1753	525	657	15.64	5.86	102.69	38.44	38.7	6.1	2.26	134.7	21.1	7.9	1.67
No. 2 II	1723	501	668	15.62	5.82	104.35	38.83	40.0	6.3	2.32	139.7	21.8	8.1	1.68
II ± I	− 30	− 24	+ 11	−0.02	−0.04	+ 1.66	+ 0.39	+ 1.3	+0.2	+0.06	+ 5.0	+ 0.7	+ 0.2	+0.01
% differences	− 2	− 5	+ 2	0	− 1	+ 2	+ 1	+ 3	+3.	+ 3	+ 4	+ 3	+ 3	+ 1

RATIONS	Total dry matter eaten	Dry matter eaten in experimental feed	Milk	Total solids	Fat	Total solids	Fat	Weight of products obtained per 100 lbs. of dry matter: In entire ration: Milk	Total solids	Fat	In experimental feed: Milk	Total solids	Fat	Ratio of percent of fat to percent of solids-not-fat
	lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
GRAIN FEED NO. 3. 23 days on each ration														
No. 3 I	467	165	334	14.00	4.71	46.65	15.66	71.5	10.0	3.36	201.8	28.2	9.5	1.97
No. 3 II	446	154	342	13.81	4.56	47.18	15.57	76.7	10.6	3.50	222.2	30.7	10.1	2.03
II ± I	− 21	− 11	+ 8	−0.19	−0.15	+ 0.53	− 0.09	+ 5.2	+0.6	+0.14	+ 20.4	+ 2.5	+ 0.6	+0.06
% differences	− 5	− 7	+ 2	− 1	− 3	+ 1	− 1	+ 7	+ 6	+ 4	+ 10	+ 9	+ 6	+ 3
GRAIN FEEDS NOS. 1 AND 3. 69 days on each ration														
No. 1	1712	490	1153	16.09	6.06	184.12	69.03	68.1	10.8	4.02	236.2	37.7	14.2	1.66
No. 3	1706	495	1153	16.16	6.19	186.05	71.27	68.4	10.9	4.15	233.0	37.6	14.4	1.61
No. 3 ± No. 1	− 6	+ 5	0	+0.07	+0.13	+ 1.93	+ 2.24	+ 0.3	+0.1	+0.13	− 3.2	− 0.1	+ 0.2	−0.05
% differences	0	+ 1	0	0	+ 2	+ 1	+ 3	0	+ 1	+ 3	− 1	0	+ 1	− 3
GRAIN FEED NO. 1. 69 days on each ration														
No. 1 I	1503	489	1223	14.58	5.11	174.14	59.18	81.5	11.6	39.5	250.0	35.6	12.1	1.85
No. 1 II	1544	489	1209	14.57	5.17	172.58	59.57	78.2	11.1	38.5	247.2	35.3	12.2	1.82
II ± I	+ 41	0	− 14	−0.01	+0.06	− 1.56	+ 0.39	− 3.3	−0.5	−0.10	− 2.8	− 0.3	+ 0.1	−0.03
% differences	+ 3	0	− 1	0	+ 1	− 1	− 1	− 4	− 4	− 3	− 1	− 1	− 1	− 2
GRAIN FEED NO. 3. 46 days on each ration														
No. 3 I	1045	305	746	14.38	4.93	107.55	36.91	71.8	10.3	35.2	246.0	35.3	12.1	1.92
No. 3 II	1047	313	746	14.42	5.01	107.93	37.53	71.3	10.3	35.6	238.9	34.4	12.0	1.88
II ± I	+ 2	+ 8	0	+0.04	+0.08	+ 0.38	+ 0.62	− 0.5	0	+00.4	− 7.1	− 0.9	− 0.1	−0.04
% differences	0	+ 3	0	0	+ 2	0	+ 2	− 1	0	+ 1	− 3	− 3	− 1	− 2
GRAIN FEEDS NOS. 1 AND 2. 138 days on each ration														
No. 1	2803	878	1816	15.06	5.39	276.35	99.35	63.7	9.6	3.46	203.0	30.7	11.0	1.79
No. 2	2737	857	1816	15.07	5.39	273.81	97.86	65.0	9.8	3.48	207.6	31.2	11.1	1.80
No. 2 ± No. 1	− 66	− 21	0	+0.01	0	− 2.54	− 1.49	+ 1.3	+ 0.2	+0.02	+ 4.6	+ 0.5	+ 0.1	+0.01
% differences	− 2	− 2	0	0	0	− 1	− 1	+ 2	+ 2	+ 1	+ 2	+ 2	+ 1	+ 1
GRAIN FEED NO. 2. 69 days on each ration.														
No. 2 I	1724	482	1183	148.4	5.30	175.54	62.62	68.7	10.3	3.64	245.4	36.4	13.0	1.80
No. 2 II	1713	489	1218	148.9	5.30	181.28	64.46	71.1	10.6	3.76	249.2	37.1	13.2	1.81
II ± I	− 11	+ 7	+ 35	+0.05	0	+ 5.74	+ 1.84	+ 2.4	+0.3	+0.12	+ 3.8	+ 0.7	+ 0.2	+0.01
% differences	− 1	+ 2	+ 3	0	0	+ 3	+ 3	+ 3	+ 3	+ 3	+ 2	+ 2	+ 2	+ 1

RATIONS	Total dry matter eaten	Dry matter eaten in experimental feed	Milk	Total solids	Fat	Total solids	Fat	Weight of products obtained per 100 lbs. of dry matter						Ratio of percent of fat to percent of solids-not-fat
								In entire ration			In experimental ration			
								Milk	Total solids	Fat	Milk	Total solids	Fat	
	lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
CORN SILAGE AND APPLE POMACE SILAGE. 276 days on each ration.														
Apple pomace....	6455	1883	4685	15.77	5.87	728.42	267.81	72.5	11.3	4.14	258.5	40.1	14.6	1.69
Corn	6137	1596	4529	15.73	5.83	701.04	255.70	73.7	11.4	4.16	293.8	45.3	16.4	1.70
Corn ± pomace...	−318	−287	−156	−0.04	−0.04	−27.38	−12.11	+ 1.2	+0.1	+0.02	+ 35.3	+ 5.2	+ 1.8	+0.01
% differences......	− 5	− 15	− 3	− 0	− 1	− 4	− 5	+ 2	+ 1	0	+ 14	+ 13	+ 12	+ 1
APPLE POMACE SILAGE. 92 days on each ration.														
Apple pomace I..	2377	233	1358	13.75	4.74	182.57	61.39	57.2	7.7	2.58	584.1	78.4	26.4	1.90
Apple pomace II..	2375	232	1302	13.85	4.81	175.66	59.62	54.9	7.4	2.52	562.1	76.0	25.8	1.88
II ± I...............	− 2	− 1	− 56	+0.10	+0.07	− 6.91	− 1.77	− 2.3	−0.3	−0.06	− 22.0	− 2.4	− 0.6	−0.02
% differences......	0	0	− 4	+ 1	+ 1	− 4	− 3	− 4	− 4	− 2	− 4	− 3	− 2	− 1
HAY VS. PUMPKINS. 92 days on each ration.														
Hay, etc............	2291		1886	13.60	4.62	185.25	61.87	60.7	8.1	2.70				1.94
Pumpkins..........	2193		1477	13.58	4.63	196.29	65.75	67.3	9.0	3.00				1.94
P'mp's ±, hay, etc.	− 98		+ 91	−0.02	+0.01	+11.04	+ 3.88	+ 6.6	+0.9	+0.30				0
% differences.......	− 4		+ 7	0	0	+ 6	+ 6	+ 11	+ 11	+ 11				0
GRAIN FEED NO. 5. 69 days on each ration.														
No. 5 I..............	1498	477	489	16.60	6.87	80.88	33.36	32.6	5.5	2.23	102.3	17.0	7.0	1.42
No. 5 II.............	1459	471	512	16.67	6.74	85.32	34.64	35.1	5.9	2.38	108.7	18.2	7.5	1.47
II ± I...............	− 39	− 6	+ 23	+0.07	−0.13	+ 4.44	+ 1.28	+ 2.5	+0.4	+0.15	+ 6.4	+ 1.2	+ 0.5	+0.05
% differences......	− 3	− 1	+ 5	0	− 2	+ 5	+ 4	+ 8	+ 7	+ 7	+ 6	+ 7	+ 7	+ 4

NOTE EXPLANATORY OF VI "DIFFERENCE TABLES," (PAGES 26-27), AND VII "RESULTS OF EXPERIMENTAL FEEDING," (PAGES 28-31).

Although "difference tables" have been printed in the last seven reports accompanied by full explanations of their meaning, they are so condensed from the data of table V that explanatory notes seem still in order.

When a cow eats a certain ration during a feeding period, another during a second period, returning to the first ration for a third period, all three being of equal lengths, and, so far as may be, all other things being equal, it is fair to assume, and in the discussion of feeding experiments it is usually assumed, that the average of the results obtained during the first and third periods on the ration then fed is what would have been secured during the second period had the feeding continued on one ration. A comparison of this average with the results actually obtained with another ration serves to show the relative value of the different fodders and feeds. The *difference between these calculated averages and the actual results* form the "differences" which measure the relative values of the two rations.

The first comparison of the record of the cow Pomona (page XVI) is given in full to show more clearly just what is meant by the figures in the "difference tables."

Record of POMONA for the experimental portions of periods I, II and III	Total dry matter eaten	Dry matter eaten in experimental feed	Milk	Total solids	Fat	Total solids	Fat	Weight of products obtained per 100 lbs. of dry matter — In entire ration: Milk	Total solids	Fat
	lbs	lbs	lbs	%	%	lbs	lbs	lbs	lbs	lbs
Average of actual records for periods I and III (medium rations)........	496.0	160.4	391.3	14.98	5.35	58.61	20.94	78.9	11.8	4.23
Actual record for period II (very low ration).....	385.7	41.4	366.3	14.41	4.89	52.79	17.91	95.0	13.7	4.64
Record made upon very low ration ± the average of those made on medium ration...............	−110.3	−119.0	−25.0	−0.57	−0.46	−5.82	−3.03	+16.1	+1.9	+0.41

The first horizontal line of figures shows the average of the records of dry matter eaten, and of milk, solids, and fat given, etc., obtained in the experimental portions of the first and third feeding periods, while the cow was eating the medium grain ration, (page XVI). The second horizontal line of figures shows the actual records of dry matter, milk, etc., obtained during the experimental portion of the second period when she ate the very low grain ration, (page XVI). The third horizontal line shows the amounts, greater or less as the case may be, of dry matter eaten, milk given, etc., when the very low ration was fed as compared with the average of the records on the medium ration. These differences furnish a measure of the relative value of the two rations, it being assumed, as stated above, that the averages correctly indicate the consumption and production which would have occurred during the intervening period had the ration remained unchanged.

The figures in the third horizontal line in the above table, together with two other sets similarly obtained by comparing Pomona's periods III and V (averaged) with IV, and Lucerne's II and IV (averaged) with III, all added, each column by itself gave the third horizontal line in table (*a*) "totals of differences," (page XXVI) beginning 3—342.4—350.6—190.6—1.00, etc. The figures in table (*b*) "percentage differences"—which are the final results and measures of the relative worth of the various rations—are obtained by dividing the "total differences" by the total actual consumption (of dry matter) or production (of milk, solids, fat and the same proportionate to 100 pounds of dry matter eaten). Thus for example, the calculated amount of dry matter eaten when the medium grain ration was fed to the cows mentioned above in the averages of the experimental portions of the periods given in couplets—for example, Pomona's I and III, and III and V,—was 1510.1 pounds. This is 342.4 pounds more than the amount actually eaten when the very low ration was fed (1167.7 pounds). Division furnishes the percentage differences, 342.4 divided by 1510.1 multiplied by 100 equals 23. The "percentage difference" is —23, or in other words, the cows when fed on the very low ration during the intermediate periods ate 23 percent less dry matter than presumedly they would have eaten had they continued on the medium ration at precisely the same time they did eat the scantier one. This figure (—23) leads the third horizontal line in table (*b*) "percentage differences," (page XXVI). Similar comparisons with the remaining items show the percent of excess or deficit of consumption or product resulting from the use of the very low ration as compared with the medium one.

The outcome of certain of the experiments is also shown in a somewhat different manner in table VII "Results of Experimental Feeding on Different Rations," wherein the total products for each period and for each calculated period are added. Thus, for example, in the case of the cows Pomona and Lucerne each fed five periods, including 10 twenty-three-day experimental portions, a comparison of 138 days feeding for one cow on each ration may be made and neither side of the comparison suffer from the effects of advancing lactation, this being equalized. The use of the data found in table V "Production Records." with the cows in question for the experimental portion of the periods stated below will give the equivalent of 138 days feeding on a medium ration.

Pomona; period III	23 days feeding
Lucerne; periods II and IV	46 days feeding
Pomona; the average of records of periods I and III and of III and V on the medium ration; equivalent respectively to what might reasonably have been expected to have been the results in periods II and IV had the feeding on the medium ration been continued	46 days feeding
Lucerne; the average of records of periods II and IV on the medium ration; equivalent, etc., to period III on the medium ration	23 days feeding
Equivalent to 138 days feeding on medium ration	

Using the data on the very low ration the following combination gives 188 days feeding:

Pomona; periods II and IV	46 days feeding
Lucerne; period III	23 days feeding
Pomona; the average of records of periods II and IV on the very low ration; equivalent, etc., to period III on the very low ration	23 days feeding
Lucerne; the average of records of periods I and III, and of III and V on the very low ration; equivalent, etc., to periods II and IV on the very low ration	46 days feeding

Equivalent to 188 days feeding on low ration

This permits the calculation of the consumption and production of each cow on each ration for the selfsame days of the experimental portion of the periods other than the first and last used with each cow, thus affording an excellent and, usually, accurate measure of the relative worth of the two rations. The result of this comparison is given at the beginning of table VII (page XXVIII) in the second set, the medium ration figures beginning 3025, 939, 2321, and the very low ration data 2383, 241, 1973. The average percentages of total solids and fat are obtained by addition and not by cross division. This gives to each cow the same influence upon the final results instead of giving greatest preponderance to those yielding most largely of milk, solids and fat, and less to those giving smaller amounts.

It should be remarked, however, that as a matter of fact exact equality cannot always be obtained by the method of calculation last referred to. When a cow maintains her milk flow fairly well, little or no trouble is encountered. When, however, considerable shrinkage occurs, the side of the comparison which includes the record of the first period has, as a rule, the advantage. In other words the figures derived from the means of the results of periods I and III, and III and V, and from the actual records of periods III and V, may have an advantage over those obtained from the means of the results of periods II and IV, and from the actual records of periods II and IV. This is due to the fact that the records of the first period, in which, often, the heaviest milk flow is given, helps on the one side of the comparison and not on the other. To be sure this side has also to carry the records of the last period, wherein, frequently, the smallest flow is given. Sometimes, but not always, these two tend to counterbalance If the shrinkage is large in the last period it is usually but not always thrown out of the experiment. The first period is seldom thus excluded however; hence occasionally this condition is met.